2014 REVISED AND UPDATED EDITION

MORE THAN 100,000 COPIES SOLD!

THE MAGNESIUM MIRACLE

Originally published as *The Miracle of Magnesium*

Discover the missing link to total health

- Lower the risk of heart disease
- Prevent stroke and obesity
- Treat diabetes
- Improve mood and memory

Carolyn Dean, M.D., N.D.

More praise for *The Magnesium Miracle*

"Every doctor and patient should read this comprehensive book on the many roles of magnesium.... I loved this book. Clearly written and packed with information, it offers a compendium on natural medicine and is an invaluable resource for both practitioner and public alike. It is the most comprehensive and well-referenced guide to the myriad benefits of magnesium published to date."

—CAROLYN DEMARCO, M.D., author of *Take Charge of Your Body: Women's Health Advisor*

"Throughout this volume and with utmost clarity, Carolyn Dean presents invaluable recommendations—based on the latest magnesium research. Virtually every American can benefit."

—PAUL PITCHFORD, author of *Healing with Whole Foods: Asian Traditions and Modern Nutrition*

"Physicians and therapists have paid scant attention to this very important element, which is also involved in maintaining our good health. The massive evidence is here in this important book on magnesium. I am pleased to have been taking magnesium for so many years."

—ABRAM HOFFER, M.D., author of *Putting It All Together: The New Orthomolecular Nutrition*

"Excellent research together with valuable inspiration to empower the doctor within each of us."

—JOSHUA ROSENTHAL, director of the Institute for Integrative Nutrition, author of *The Energy Balance Diet*

"An enlightening and practical book. Dr. Dean supplies powerful information for people while trumpeting a reminder to doctors about this essential and often overlooked mineral elixir. *The Magnesium Miracle* should be required reading for living a rich, healthy life."

—EUGENE CHARLES, D.C., DIBAK, author of *Physician Heal Thy Patient* and *Becoming Healthy, Wealthy and Wise*

"I have been in complementary medicine for thirty years and I believed I knew all there was to know about magnesium—until I [read] the latest book by Dr. Carolyn Dean. This book is the most comprehensive review on the subject I have ever read. As one can expect from a physician with such vast and diversified knowledge, *The Magnesium Miracle* contains information on allied fields of medicine that makes this book an incredible resource for doctors and patients alike. *The Magnesium Miracle* is a book that is going to be of great service to humanity since, as the author points out, there is so much information on magnesium that has failed to be included in the medical curriculum."

—SERAFINA CORSELLO, M.D., Wellness Medical Center for Integrative Medicine, author of

Ageless Healing

THE MAGNESIUM MIRACLE

2014 Revised and Updated Edition

(Originally published as
The Miracle of Magnesium)

Carolyn Dean, M.D., N.D.

Ballantine Books New York

2014 Ballantine Books eBook Edition Copyright © 2003, 2007, 2014 by Carolyn Dean, M.D., N.D.
Foreword copyright © 2003 by Dr. Bella Altura and Dr. Burton Altura All rights reserved.

Published in the United States by Ballantine Books, an imprint of Random House, a division of Random House LLC, a Penguin Random House Company, New York.

BALLANTINE and the HOUSE colophon are registered trademarks of Random House, Inc.

Originally published in hardcover and trade paperback in different form as *The Miracle of Magnesium* by Ballantine Books, an imprint of Random House, a division of Random House LLC in 2003 and 2007 respectively.

ISBN 978-0-345-49458-0
eBook ISBN 978-0-307-55769-8

www.ballantinebooks.com

Cover design: Karen Lau

v3.1_r2

CONTENTS

Cover
Copyright
Foreword to the First Edition
Introduction

PART ONE: THE HISTORY OF MAGNESIUM

1 The Case for Magnesium
2 Magnesium: The Missing Mineral

PART TWO: MAGNESIUM-DEFICIENT CONDITIONS

3 Anxiety and Depression
4 Migraines and Pain
5 Strokes, Head Injury, and Brain Surgery
6 Cholesterol and Hypertension
7 Magnesium and Heart Disease
8 Obesity, Syndrome X, and Diabetes
9 PMS, Dysmenorrhea, and Polycystic Ovarian Syndrome
10 Infertility, Pregnancy, Preeclampsia, and Cerebral Palsy
11 Osteoporosis and Kidney Stones

PART THREE: THE RESEARCH CONTINUES

12 Chronic Fatigue Syndrome and Fibromyalgia

13 Environmental Illness
14 Asthma
15 Health and Longevity

PART FOUR: TESTING AND SUPPLEMENTS

16 Magnesium Requirements and Testing
17 A Magnesium Eating Plan
18 Magnesium Supplementation and Homeopathic Magnesium

Dedication
Appendix
- Magnesium Content of Common Foods
- Calcium Content of Common Foods

Resources
References
About the Author

FOREWORD TO THE FIRST EDITION

"Clearly there is more to life than magnesium" is one of the remarks from Dr. Dean's remarkable, almost encyclopedic, but very readable book. Her book is long overdue, for it gives the lay reader a chance to discover for him-or herself the many needs for this mineral in a healthy diet, and the reasons why this has not been emphasized in the everyday literature.

The requirement for magnesium in our diet is indeed a much neglected topic, and this book by Dr. Dean brings the message home by her carefully written repetitive emphasis on the subject. That does not mean that there are not many other nutrients necessary in our daily food intake, as stated above, but the point she so clearly makes is that the public in general has not been notified to look for the proper amount of this mineral in the daily diet and of the many reasons magnesium is needed in our bodies.

After a cursory overview of the material, the book should be read as one would read an encyclopedia, that is, pick out the parts one is particularly interested in, and then go back and try to read it all. This way the reader will get the gist of how important magnesium really is and how little he or she has been informed, be it from newspapers, magazines, or the rest of the news media. As the old adage says, "An ounce of prevention is worth a pound of cure," and so it is with balanced nutrition, which includes this all-important mineral in adequate amounts. (As to the other

interesting parts of the book, our qualifications allow us to comment only on the material pertaining to the scientific basis for the need of magnesium.)

DR. BELLA T. ALTURA Research Professor of Physiology and Pharmacology SUNY Downstate Medical Center Brooklyn, New York

DR. BURTON M. ALTURA Professor of Physiology, Pharmacology, and Medicine SUNY Downstate Medical Center Brooklyn, New York

INTRODUCTION

I'm very grateful to Random House for publishing the third edition of *The Magnesium Miracle*, and I have enjoyed writing it. This book has been a bestseller since it first appeared in 2003, periodically moving into the top 100 and typically holding the position of number one supplement book on Amazon. *The Magnesium Miracle* has helped many thousands and saved innumerable lives.

With this edition of *The Magnesium Miracle*, I want to emphasize the following points:

1. Most people have magnesium deficiency, so this book is for you.
2. There are many reasons why magnesium deficiency occurs; knowing what causes yours will help motivate you to improve your magnesium status.
3. Magnesium can be safely taken to help treat dozens of health conditions.
4. You can take one or more of the various forms of magnesium that I talk about below to achieve your optimum magnesium levels.
5. A simple blood test can help assess magnesium deficiency, and repeating the test periodically helps you adjust your magnesium dosage to keep your levels in an optimum range. (See this page, "Testing for Magnesium Deficiency.")

Since the second edition of *The Magnesium Miracle*, published in December 2006, I've been amazed at the explosion of magnesium research and the magnesium miracles stories I've received. I feel compelled to pass on all this new information to readers. The reasons magnesium is so important and why it's become so deficient are still the same as I reported in previous editions, but I've come to learn more about the many preventable causes of magnesium deficiency and why its ability to help people is not more widely promoted.

I'm also happily amazed at the number of people who've taken up the torch of magnesium to help educate their family, friends, and even complete strangers. Several readers of my blog keep a copy of *The Magnesium Miracle* with them at all times, ready to give it to anyone who mentions magnesium deficiency symptoms in their presence!

One magnesium enthusiast has made himself an expert on magnesium in the past two years, crediting me and *The Magnesium Miracle* with lighting a magnesium fire under him. Morley Robbins calls himself a recovering hospital executive and hopes to atone for his previous life by educating as many people as possible about the magic of magnesium. Morley's passion for magnesium and his ability to dig up important old and new studies demonstrating its miraculous powers inspired me to pursue this third edition of *The Magnesium Miracle* and also reminded me that magnesium is by far the most important nutrient in the body.

A June 2013 Medline search for magnesium turned up

85,971 published papers. Human studies make up 28,718 of that total. Almost 2,000 magnesium studies are being published each year, with 9,202 studies published in the past five years in medical journals enumerated by Medline. Below, I've greatly expanded the list "What Does Magnesium Do?" into "Magnesium's Many Roles."

MAGNESIUM'S MANY ROLES

The list I produced on the roles of magnesium on this page of *The Magnesium Miracle* is not nearly complete. In it I only covered five general functions:

1. Catalyzing most chemical reactions in the body
2. Producing and transporting energy
3. Synthesizing protein
4. Transmitting nerve signals
5. Relaxing muscles

Below I've listed fourteen major magnesium functions, and it's very likely there are many more.

Over the years I've realized that magnesium is much more complex than I ever thought possible. The following fourteen functions are listed in a textbook on magnesium, and I've included additional information on its functions and metabolism.[1] Some of the language may be technical, but I want to give you a sense of the sophistication of this simple mineral. As you read what magnesium is capable of doing, just imagine how many necessary functions are interrupted when you become deficient, as most of the population is.

1. ***Magnesium is a cofactor for the enzyme ATP (adenosine triphosphate).*** ATP, created in mitochondria, is the main source of energy in our cells, and it must be bound to a magnesium ion (MgATP) in order to be biologically active. This is

likely the most important function of magnesium, because ATP is made in each of the 100 trillion cells in our body.

ATP is formed from our food (carbs, fats, and proteins) in a series of chemical reactions called the Krebs cycle. In that cycle an incredible seven out of a total of ten enzymes are dependent on magnesium.[2,3]

ATP has many other functions besides making energy. Transmembrane ATP imports substances necessary for cell metabolism and exports toxins and wastes across cell membranes. A hydrogen-potassium ATP called the gastric proton pump acidifies the contents of the stomach. Many other pumps and transporters are all directed by ATP with magnesium as its necessary cofactor.

2. ***Magnesium is an important membrane stabilizing agent***. Stabilization decreases excitation of nerves and contraction of muscle cell membranes.

3. ***Magnesium is required for the structural integrity of numerous body proteins***. To date, 3,751 magnesium receptors sites have been found on human proteins.

4. ***Magnesium is required for the structural integrity of nucleic acids***. Consequently, magnesium is a requirement for RNA and DNA production.

5. ***Magnesium is a cofactor for the enzyme guanosine triphosphatase***. GTP has many functions: (a) signal transduction, or "switching" on specific receptor proteins on cell membranes and transmitting

that signal to trigger taste, smell, and perception of light; (b) protein biosynthesis; (c) control and differentiation of cell division; (d) translocation of proteins through cell membranes; and (e) transport of vesicles within the cell and assembly of vesicle coats.

6. ***Magnesium is a cofactor for the enzyme phospholipase C***. PLC is a class of enzymes that split phospholipids at the phosphate group, creating signal transduction pathways, among other things.

7. ***Magnesium is a cofactor for the enzyme adenylate cyclase***. This enzyme converts ATP to cAMP and pyrophosphate. cAMP is used for intracellular signal transduction of the effects of hormones like glucagon and adrenaline into cells because the hormones can't pass through cell membranes. cAMP is involved in the activation of protein kinases and regulates the effects of adrenaline and glucagon. It also binds to and regulates the function of ion channels or gateways into the cell.

8. ***Magnesium is a cofactor for the enzyme guanylate cyclase***. This enzyme synthesizes cyclic guanosine monophosphate (cGMP) from guanosine triphosphate (GTP), keeping cGMP-gated ion channels open, allowing calcium to enter the cell. cGMP is an important second messenger that transmits the message across cell membranes from peptide hormones and nitric oxide, and it can also function as a hormone signal. It can trigger changes requiring protein synthesis. In smooth muscle, cGMP is the signal for relaxation, which can regulate vascular and airway

tone, insulin secretion, and peristalsis.

9. ***Magnesium is a required cofactor for the activity of hundreds of enzymes***. I quoted the standard number of 325 enzymes when I wrote the first edition of *The Magnesium Miracle*. However, the number 325 is far too low. Dr. Rosenoff says, "While it was estimated in 1968 that magnesium was a required cofactor for over 300 enzyme systems, that number is now more reliably estimated at 700 to 800."[4]

10. ***Magnesium is a direct regulator of ion channels, most notably of the other key electrolytes, calcium, sodium, and potassium***.

Magnesium is intimately involved in potassium transport. Magnesium and potassium depletion cause similar damaging effects on the heart. Furthermore, it's impossible to overcome potassium deficiency without replacing magnesium. That's why hospitals seem to have such a difficult time finding the right electrolyte balance of sodium, potassium, calcium, and chloride, because they ignore magnesium.

Magnesium is intimately involved in calcium channels. On this page, I write about magnesium guarding the ion channels that allow calcium to enter and leave the cell, orchestrating the exact amount of calcium that's required to cause a muscle or nerve cell to contract and then flushing that extra calcium out to prevent excessive contraction.

Magnesium is a natural calcium channel blocker. But instead of using magnesium to modify the effect of calcium on body physiology, allopathic medicine

insists on using calcium-channel-blocking drugs that have many side effects.

11. ***Magnesium is an important intracellular signaling molecule itself***. I've mentioned signaling several times; the role of cell signaling cannot be underestimated. It's only due to this type of intercellular communication that the cells of the body function at all.

12. ***Magnesium is a modulator of oxidative phosphorylation***. During oxidative phosphorylation, electrons are transferred from electron donors to electron acceptors such as oxygen in redox reactions, using magnesium as a cofactor. These redox reactions, called electron transport chains, form a series of protein complexes within the cell's mitochondria that release energy, which is used to form ATP.

13. ***Magnesium is intimately involved in nerve conduction***. Later in the introduction you'll read about the detrimental effects of excess calcium. Although calcium is vital for proper nervous system function, too much calcium is dangerous. Excess calcium is proinflammatory and can excite nerves to the point of cell death.

14. ***Magnesium is intimately involved in muscle function***. The mechanisms are varied and include oxygen uptake, electrolyte balance, and energy production. Magnesium makes muscles work properly, allowing calcium to cause muscle contraction and then pushing calcium out of the

muscle cells to allow the relaxation phase. In the same way that nerve cells can be “excited to death,” muscle cells stimulated by too much calcium can go into uncontrollable spasm, resulting in tissue damage such as occurs in a heart attack.

LONG-STANDING MAGNESIUM DEPLETION

The following statement was read into the record of the 74th Congress, 2nd session, (Senate document no. 264), 1936. What we knew almost a century ago about the mineral depletion of our agricultural soil has only gotten worse.

Do you know that most of us today are suffering from certain dangerous diet deficiencies which cannot be remedied until depleted soils from which our food comes are brought into proper mineral balance? The alarming fact is that foods (fruits, vegetables, and grains) now being raised on millions of acres of land that no longer contain enough of certain minerals are starving us—no matter how much of them we eat. The truth is that our foods vary enormously in value, and some of them aren't worth eating as food.

Our physical well-being is more directly dependent upon the minerals we take into our systems than upon calories or vitamins or upon the precise proportions of starch, protein, or carbohydrates we consume.

Laboratory tests prove that the fruits, the vegetables, the grains, the eggs, and even the milk and the meats of today are not what they were a few generations ago. No man today can eat enough fruits and vegetables to supply his stomach with the mineral salts he requires for perfect health, because his stomach isn't big enough to hold them! And we are turning into a nation of big

stomachs.

MAGNESIUM-DEFICIENT DIET

There has been a gradual decline of dietary magnesium in the United States, from a high of 500 mg/day at the turn of the century to barely 175–225 mg/day today.[5] The National Academy of Sciences has determined that most American men obtain only about 80 percent of the recommended daily allowance (RDA), and women average only 70 percent.[6] Our concern about magnesium adequacy is heightened when we learn that many magnesium experts say the current RDA is inadequate to prevent magnesium deficiency.

Are any of the current fad diets closing the gap on magnesium deficiency? Not at all. The Paleo Diet, for example, tells people to avoid grains, throwing more people into magnesium deficiency. They don't mention, as I do on this page, that in order to digest a protein diet, more magnesium is required. Furthermore, on this page, I note that the major enzymes involved in homocysteine metabolism are magnesium-dependent. Homocysteine is a normal by-product of protein digestion, but in excess it oxidizes cholesterol, which damages blood vessels. This entire process of oxidative degradation of fats (lipid peroxidation) occurs when there is a lack of magnesium.

A diet high in sugar and other simple carbohydrates also puts you at risk for magnesium deficiency. According to Natasha Campbell-McBride in her book *Gut and Psychology Syndrome* (2010), twenty-eight atoms of magnesium are required to process one molecule of glucose. If you are trying to break down a molecule of fructose, you need fifty-six atoms of magnesium. That's an extremely unbalanced

and unsustainable equation.

Even the raw-foodists and green-juicers are not immune to magnesium deficiency. Magnesium is the central mineral in "plant blood," or chlorophyll, much as iron is the central mineral in hemoglobin. You would think a diet high in green vegetables would have you covered. Not so. I have consulted with people who are drinking more than 100 ounces of organic green juice a day yet are still magnesium deficient, with symptoms of heart palpitations and leg cramps. Let me repeat this fact: if the food you are eating is not grown on soil replenished with minerals, the food will automatically be mineral deficient.

THE CLINICAL IMPACT OF MAGNESIUM DEFICIENCY

Magnesium was first discovered in huge deposits near a Greek city called Magnesia. Magnesium sulfate, known today as Epsom salts, was used in ancient times as a laxative, and still is to this day. A 1697 medical paper, with some exaggerated unscientific enthusiasm, recommended magnesium for conditions as varied as skin ulcers, depression, vertigo, heartburn, worms, kidney stones, jaundice, and gout. Most of these conditions are still treated with magnesium, and current research now supports its use for many of those early conditions in a long list of ailments that you will read about in *The Magnesium Miracle*

FIFTY-SIX CONDITIONS ASSOCIATED WITH MAGNESIUM DEFICIENCY

In the introduction to the original *Magnesium Miracle*, I listed twenty-one conditions that have a direct clinical correlation with magnesium deficiency and responded to magnesium treatment. From more recent magnesium research and clinical experience I've expanded this list to thirty-seven; including subcategories, this adds up to fifty-six conditions.

1. ***Acid reflux***. Spasm of the lower esophageal sphincter at the juncture of the stomach can cause acid reflux. Magnesium relieves esophageal spasms.

2. ***Adrenal fatigue***. Adrenal fatigue follows after a time of chronic stress, anxiety, and panic attacks and it seems to be occurring in epidemic proportions. Adrenaline, noradrenaline, and cortisol (elevated in chronic stress) deplete magnesium. Stress causes excess elimination of magnesium through the urine, further compounding magnesium deficiency. *Stress* is such an overworked word, but we all suffer physical, emotional, and mental stress every day, and every bit of it drains magnesium.

3. ***Alzheimer's disease***. Magnesium blocks the neuroinflammation caused by the inappropriate deposition of calcium and other heavy metals in brain cells. Magnesium is at work even before the inflammation appears, guarding cell ion channels and not allowing heavy metals to enter.

4. ***Angina***. The pain of angina is caused by severe

muscle spasm in heart muscles, which in turn is caused by magnesium deficiency. The heart ventricles have the highest levels of magnesium in the whole body, which is why magnesium is so important for the pumping function of the heart.

5. ***Anxiety and panic attacks***. When the adrenals are no longer protected by sufficient magnesium, the fight-or-flight hormones adrenaline and noradrenaline become more easily triggered, and when they surge erratically, they cause a rapid pulse, high blood pressure, and heart palpitations. In fact, the more magnesium deficient you are, the more exaggerated is the adrenaline release. On this page, I say, "There are over a dozen major metabolic processes that are affected by adrenaline.... Each of these functions requires magnesium and leads to wasting of this important mineral if the symptoms continue." Magnesium calms the nervous system and relaxes muscle tension, helping reduce anxiety and panic attacks.

6. ***Arthritis***. Pain and inflammation are two major symptoms of arthritis that are amenable to treatment with magnesium.

7. ***Asthma***. Histamine production and bronchial spasms (in the smooth muscles of the bronchial tract) both increase simply as a result of magnesium deficiency.

8. ***Atherosclerosis with calcium deposits***. Magnesium is necessary to help dissolve calcium and

keep it soluble in the bloodstream. Magnesium, along with vitamin K_2, helps direct calcium to the bones, where it belongs.

9. ***Blood clots***. Magnesium does not act like blood-thinning drugs but instead helps prevent blood clots by preventing excess calcium from triggering them, and it naturally balances the blood clotting factors in the blood as required.

10. ***Bowel disease***. Magnesium deficiency slows down bowel peristalsis, causing constipation, which could lead to toxicity as well as symptoms of colitis, diverticulitis, and Crohn's disease.

11. ***Brain dysfunction***. See the book *Magnesium in the Central Nervous System* (2011; see page xxxii) for an extensive overview of the beneficial effects of magnesium on the brain.

12. ***Cholesterol elevation***. When I was in medical school in the mid-1970s, normal cholesterol levels were around 245 mg/dL. The first editions of *The Magnesium Miracle* had the normal value of cholesterol at 180–220 mg/dl. Now, medical centers are advising that cholesterol should be below 200 mg/dL (5.2 mmol/L) to be considered normal. Magnesium is responsible for slowing down HMG-CoA reductase activity when cholesterol is present in sufficient quantities. This is the same enzyme that statin drugs target for destruction, while creating magnesium deficiency.

13. ***Cystitis***. Magnesium deficiency causes bladder

spasms during an infection. But a spastic bladder can cause urinary frequency at any time.

14. ***Depression***. Serotonin, which elevates mood, is dependent on magnesium. A magnesium-deficient brain is also more susceptible to allergens and foreign substances, which in some instances can cause symptoms similar to mental illness.

15. ***Detoxification***. Magnesium is crucial for the removal of toxic substances and heavy metals such as mercury, aluminum, and lead from the body. Magnesium is a cofactor in the production of glutathione and the function of the P450 detoxification systems in the liver. MgATP energizes the important GSH and thiol detox pathways.

16. ***Diabetes***. Magnesium enhances insulin secretion, facilitates carbohydrate metabolism, and allows insulin to transfer glucose into cells. Otherwise, glucose and insulin build up in the blood causing various types of tissue damage. Tyrosine kinase, the enzyme that allows insulin entry into the cell, is magnesium-dependent. Seven of the ten enzymes needed to metabolize glucose are also magnesium-dependent. You cannot make or secrete insulin without magnesium.

17. ***Fatigue***. Magnesium-deficient patients commonly experience fatigue because dozens of enzyme systems are underfunctioning. The most important factor in energy production is ATP, which must be bound to a magnesium ion in order to be biologically active.

18. ***Headaches***. The muscle tension and spasm in

neck and head muscles can be alleviated with magnesium therapy, which can be both applied locally and taken orally.

19. ***Heart disease***. As noted, the heart, specifically the left ventricle, has the highest amount of magnesium in the whole body. Magnesium deficiency is common in people with heart disease, and taking magnesium can reduce that risk. IV magnesium can prevent myocardial infarction damage and cardiac arrhythmia if given at the onset of a heart attack. I'm very concerned that many people are diagnosed with heart disease and put on at least six heart medications and before long may be told they have heart failure when all along they had magnesium deficiency. Unfortunately, most of the drugs used in treating heart disease drain magnesium from the body. The statins are especially damaging because they are mostly fluoride compounds that bind magnesium, making it unavailable in the body. See "Fluoride Binds Magnesium" on this page.)

20. ***Hypertension***. With insufficient magnesium and too much calcium, the muscles in blood vessels can go into spasm and cause high blood pressure. If cholesterol also rises, due to magnesium deficiency, it can bind to calcium in the blood vessels, worsening high blood pressure.

21. ***Hypoglycemia***. Magnesium balances the release of insulin so that inappropriately large amounts don't cause the blood sugar to drop suddenly, resulting in symptoms of low blood sugar.

22. ***Indigestion***. The gastric proton pump that acidifies the contents of the stomach is dependent on magnesium.

23. ***Inflammation***. The February 2004 issue of *Time* warned the public about "The Secret Killer: The Surprising Link between Inflammation and Heart Attacks, Cancer, Alzheimer's and Other Diseases." Most drug companies are now embracing inflammation and not cholesterol as the cause of heart disease. They claim they don't know what's really causing the inflammation, but that doesn't stop them from producing drugs to suppress it. What they don't acknowledge is that calcium is extremely proinflammatory and magnesium is very anti-inflammatory. I have grave concerns that researchers are trying to block inflammatory receptors with drugs that cause inflammation. They need to acknowledge the research of William Weglicki and Terry Phillips, who proved that the entire inflammatory cascade (substance P, interleukins, tumor necrosis factor, chemokines, and cytokines) escalate when magnesium is deficient.[7] The bottom line is that inflammation is triggered by magnesium deficiency and the relative calcium excess.

24. ***Insomnia.*** Magnesium prevents muscle tension that can prevent restful sleep. Also, sleep-regulating melatonin pathway production is disturbed without sufficient magnesium.

25. ***Irritable bowel syndrome***. In my book *IBS for*

Dummies, I describe the need for magnesium to treat the pain and spasm of IBS. The more laxative forms of magnesium can also treat IBS-related constipation.

26. ***Kidney disease***. Magnesium deficiency contributes to atherosclerotic kidney failure. Magnesium deficiency creates abnormal lipid levels and worsening blood sugar control in kidney transplant patients. It's important for kidney patients to receive magnesium in the picometer size that is absorbed directly into cells.

27. ***Kidney stones***. See Chapter 11 for evidence of magnesium's ability to prevent and treat kidney stones, especially when combined with its partner, vitamin B_6.

28. ***Migraine***. Serotonin balance is magnesium-dependent. Deficiency of serotonin can result in migraine headaches and depression. Blood clots are said to clog up tiny brain blood vessels, leading to migraines. Magnesium prevents calcium from causing excessive blood clotting. IV and oral magnesium can treat and prevent migraine headaches.

29. ***Musculoskeletal conditions***. Insufficient magnesium and the relative excess of calcium will cause sustained muscle contraction in any muscle of the body. All of the following musculoskeletal conditions are amenable to magnesium therapy:

    a. Muscle cramps

    b. Fibrositis

c. Fibromyalgia

d. GI spasms, gallbladder spasms can lead to surgery

d. Tension headaches

e. Muscle spasms, muscle contractions in any muscle of the body

f. Chronic neck and back pain

30. ***Nerve problems***. Insufficient magnesium and the relative excess of calcium will cause sustained nerve excitation in any nerve cells of the body. Magnesium alleviates the following nerve disturbances that can occur throughout the body:

a. Burning

b. Muscle weakness

c. Numbness

d. Paralysis and sensitivity

e. Pins-and-needles sensations

f. Seizures and convulsions

g. Twitching

h. Vertigo and confusion

31. ***Obstetrical and gynecological problems***. Magnesium helps prevent and treat the following:

a. Premenstrual syndrome

b. Dysmenorrhea (cramping pain during menses)

c. Female infertility (by relieving fallopian tube spasm)

d. Premature contractions (which can be triggered by magnesium deficiency muscle spasms)

e. Preeclampsia and eclampsia in pregnancy (treating fluid retention, high blood pressure, and seizures)

f. Cerebral palsy

g. Sudden infant death syndrome (SIDS)

h. Male infertility (magnesium and zinc are present in significant quantities in healthy semen)

32. ***Osteoporosis***. High-dose calcium with or without vitamin D without a balancing amount of magnesium triggers a cascade of events leading to bone loss.

33. ***Parkinson's disease***. Magnesium blocks the neuroinflammation caused by calcium deposits in the brain.

34. ***Raynaud's syndrome***. Magnesium helps relax the spastic blood vessels that cause pain and numbness of the fingers.

35. ***Sports injuries***. Pain, inflammation, muscle spasm, muscle tension, and scarring can all be treated with magnesium.

36. ***Sports recovery***. Magnesium reduces lactic acid buildup that can result in post-exercise pain.

37. ***Tooth decay***. Magnesium deficiency causes an unhealthy balance of phosphorus and calcium in saliva, which damages teeth.

When people tell me they are taking magnesium and still have magnesium deficiency symptoms, it usually means they aren't taking enough. I encourage them to find out by ordering a magnesium RBC test (see this page).

When you or your doctor don't realize that the above fifty-six conditions can be due to magnesium deficiency and are treatable with magnesium, you may be prescribed drugs. Unfortunately, drugs such as painkillers, diuretics, antibiotics, and cortisone, many of which are inappropriately used for the aforementioned conditions, further deplete magnesium and other minerals, allowing symptoms to get completely out of control.

A study from the Mayo Clinic hit the media with the following sensational headline: "Study Shows 70 Percent of Americans Take Prescription Drugs." The Mayo study searched the prescription records for 147,377 patients, finding that almost 70 percent of Americans are on at least one prescription drug, and more than 50 percent take two. Twenty percent of patients are on five or more prescription medications, and one in four women between the ages of fifty and sixty-four is on antidepressants. Expenditures on prescription drugs reached $250 billion in 2009 and accounted for 12 percent of total personal health care expenditures. According to the Centers for Disease Control and Prevention, the percentage of people using at least one prescription drug in the past month increased nearly 50 percent between 2007 and 2010. Furthermore, the researchers predict that there is no end in sight and that prescription drug spending will only increase in the future.

In spite of warnings about the danger of using antibiotics

when not needed, they are the most-prescribed drugs. In spite of the fact that antidepressants only work 40 percent of the time, they are the second most-prescribed drugs. In spite of the fact that painkilling opioids are highly addictive, they are the third-most-prescribed drugs. And in spite of the fact that statin drugs don't let you live any longer, they are the fourth-most-prescribed drugs.

MAGNESIUM AND YEAST OVERGROWTH

A powerful trigger of inflammation is uncontrolled yeast overgrowth. Yeast produces 178 different chemical antigens in its normal life cycle. These chemicals can be absorbed into the bloodstream and set up a never-ending inflammatory cascade. Acetaldehyde is one of the powerful toxic by-products of yeast, and magnesium is required to break it down. If there isn't enough magnesium, unopposed acetaldehyde can cause many side effects. Besides candida, exposures to acetaldehyde occur due to alcohol consumption, exhaust from cars and trucks, cigarette smoking, and the use of high-fructose corn syrup.

Acetaldehyde is toxic to the brain, liver, and kidney and can cause depletion of B vitamins. It also can block hormone receptors affecting the thyroid, adrenals, and pituitary. Symptoms of thyroid imbalance are very common today partly because thyroid hormones, which may appear normal in blood tests, can't get inside cells to do their work as a result of chronic acetaldehyde poisoning. The same happens with female hormones, especially estrogen not getting into cells, whereas blood estrogen levels may be normal.

MAGNESIUM AND JANE'S TOP TEN IMPROVEMENTS

One woman in her early fifties, whom I'll call Jane, filled out my client symptom survey and scored 275. A healthy person would have no symptoms or maybe a score of 10. After three months on magnesium treatment, Jane sent me a list of the top ten improvements she'd seen.

1. ***Less knee pain***. Our knees take the brunt of our weight. The knee is just a simple hinge joint that is held in place by the thigh and leg muscles. If those muscles are tight or in spasm, that alone can cause a slight displacement of the knee, which over time can turn into what medicine calls "knee arthritis." However, instead of immediately going on pain medication or undergoing knee surgery to "clean out the joint," magnesium is the treatment of choice.

2. ***Carbohydrate/sugar cravings down from 90 to 5 (on a scale of 0–100)***. Magnesium is a necessary cofactor in the proper metabolism of carbohydrates. It also helps insulin work properly to put sugar inside cells, where it belongs, and not leave it in the bloodstream, where it can continue to cause sugar cravings.

3. ***Facial wrinkles and crevices diminishing***. This is a new benefit of magnesium that I hadn't heard before, but Jane is a very observant lady. I'm sure others are receiving the benefit of magnesium in this way but aren't taking note. It's likely to do with tissue integrity, hydration, and cell health, all of which are important effects of magnesium balance.

4. ***Dramatic reduction in migraines***. Migraines can cause the most severe pain known to humans. They are debilitating and said to be incurable. Lifelong use of pain medication seems to be the only option that doctors can offer. However, Jane and thousands of other readers of my *Magnesium Miracle* book have found relief from migraines and headaches by using magnesium. In the book, I talk about also using the herb feverfew and some vitamin B_6 (25 mg twice a day) if magnesium alone doesn't give full relief.

5. ***Periods went from dark to bright red, and from severe clots to minimal***. Magnesium works in several ways to lessen the intensity of menstrual flow. It facilitates the oxygenation of the blood and detoxifies it, changing a dark toxic flow to a bright red one. It also thins the blood naturally, breaking up clots.

6. ***Able to exercise intensively for the first time in years***. Prior to this, Jane would be exhausted for at least three days after any exercise. (See this page for the section on magnesium and muscles to understand the effect of exercise on magnesium.) In Jane's case, it was probably a combination of things. She likely didn't have enough magnesium to neutralize the lactic acid she was building up, so instead she got aches and pains. Also, one of the first symptoms of magnesium deficiency is fatigue. When you lack ATP, the energy packets that are formed with the help of magnesium just doesn't have the oomph that you want. Some people find that exercise gives them energy, but in order to get this boost they have to have enough ATP.

7. ***Sleep has improved (from "minimal" to "poor and restless" all night)***. When your body is magnesium deficient, it's as if your cells and nerves are all on edge. They are tight and contracted and ready to snap. If you lie down in that state, your body can't relax, your mind can't relax, and you toss and turn. Simply having the proper amount of magnesium turns off that tension, relaxes your muscles, and allows you to slip into sleep.

8. ***Able to keep going to some extent past 6:30 p.m.*** Without enough magnesium, the energy the body gets from ATP is diminished and people have no staying power.

9. ***Less sound sensitivity/hypersensitivity***. Studies done in the cockpit on pilots showed an increased sound sensitivity in the face of magnesium deficiency. Once when I was on a radio talk show a woman phoned in and asked about her son, who was in a rock band. I had been talking about tics and spasms being a sign of magnesium deficiency. She said that her son had developed a tic below one eye and wondered if it could be magnesium deficiency. I said it absolutely could.

10. ***Better able to concentrate when someone is speaking to her***. Jane had been finding that her concentration was hampered, especially if there was a lot of background noise. Poor concentration is not something you will find in a list of symptoms of magnesium deficiency. However, it makes sense that if your body is tense and irritable and you are sound

sensitive, then you can have trouble concentrating.

MAGNESIUM AND BLEPHEROSPASM

A dentist from Mexico wrote to me telling me of twenty symptoms that have improved with magnesium, but the most dramatic was her "incurable" eye blinking.

> Hello, Dr. Dean. I'm a Mexican dentist, forty-two years old. In June 2002, I started feeling "sand" in my eyes and went to an ophthalmologist, whose diagnosis was allergic dermatoconjuntivitis, and I was prescribed some ointments and drops for my eyes. They didn't work, so I went to see another four ophthalmologists, and they changed the diagnosis to keratitis. In the meantime I started to develop eye blinking that got worse and worse until it became such a severe spasm that I couldn't open my eyes. I also started having tetany. From the first doctor until this point, two months had passed. Needless to say, I was desperate and very depressed. I couldn't work, drive, or even walk! Then I went to see a neuro-ophthalmologist who gave me the terrible diagnosis of essential blepharospasm, which means that they don't know what causes it and of course there is no cure. He also told me that this was known as "Meige syndrome," and he offered me three options:
>
> 1. To take neurological prescriptions (sedatives for life), which would have to be

changed every three months because they lose their effect.

2. Botox injections, with the risk that the eyelid could droop.

3. A facial nerve blockage (the motor part) in my face. The treatment is horrible: they give you shots all around the forehead and eyelids with an alcohol-derived substance; the injections goes to the depth of the bone.

He recommended that I try number three first, so I accepted the treatment. This was in August 2002. Let me tell you that it was a *horrible* experience. My face was swollen to at least five times normal size, and he definitely did something wrong, because he left me with facial paralysis on the left side. So my right eye couldn't close and my left eye was still closed because it didn't respond to the shots. He prescribed me cortisone and told me that we had to wait and see what happened. I was feeling miserable.

And then, the miracle happened: I needed something to be fixed in my kitchen, and the person who came to do the job brought this book about magnesium. It caught my attention because I had started to take a calcium-magnesium supplement because someone told me that it was very good for stress. By this time I couldn't read because the eye drops I was

using caused mydriasis (excessively dilated pupils). I asked him to lend me the book so I could make a copy to read it later.

The next day he arrived with my copy, and since I could do absolutely nothing else, I made a huge effort and started to read the book, line by line. As I got further and further, I realized that almost everything that I was reading was about the health problems I've had my whole life, so I started to take magnesium.

I got magnesium chloride in drops and started to take it in November 2002. I began to improve week by week. Four weeks later the paralysis was gone and the blepharospasm was improving beautifully. Then I started research on the Internet. In December, I went to the United States and bought magnesium glycinate and started taking 600 mg per day in three doses. And besides the blepharospasm and paralysis, these are all my other symptoms that are diminishing day by day:

1. Chronic fatigue syndrome
2. PMS
3. Excessive emotional stress
4. Joint pain
5. Back and neck pain
6. Constipation
7. Anxiety

8. Nervousness
9. Arrhythmia
10. Cystitis
11. Colitis
12. Bad circulation
13. Cold hands and feet
14. Feeling disoriented in space and time
15. Depression without apparent cause and inability to cope with everyday things
16. Flatulence
17. Mood swings
18. Hormonal imbalance

They are not 100 percent gone, but almost! The "incurable" blepharospasm has almost disappeared, and I feel that it will very soon be gone completely. I'm taking 800 mg of magnesium per day (400 mg in the morning and 400 mg before going to bed). I'm also taking flaxseed oil and a multivitamin for women. I wanted you to know my story because if someone has had the same diagnosis, I want them to know that there is hope that this is curable with the miracle of magnesium. Thank you very much!

MAGNESIUM AND MIGRAINE

In Chapter 4, I discuss migraine headaches and how magnesium helps treat the underlying causes. But first, does allopathic medicine have anything new to offer migraine sufferers? Unfortunately not, and a new class of migraine drugs is now suspected of doing more harm than good.

The triptans comprise about sixteen tryptamine-based drugs that are painkillers and not specifically a cure for migraine. Triptans, approved by the FDA in the 1990s, manipulate serotonin, but their mechanism of action is still not known. Millions of prescriptions have been written, but a presentation at the 2013 International Headache Congress on the American Migraine Prevalence and Prevention (AMPP) study found that there is a heart disease contraindication to taking triptans for at least five million Americans. The study spokesperson, Dr. Dawn Buse, found it "a sizeable concern," noting that "These data highlight an area of unmet need for acute migraine treatment without cardiovascular risk and contraindications." I would add that we also need a migraine drug that works in more than 20 percent of migraine patients, which is the success rate for triptans.

The triptans that cause heart disease are probably doing so by depleting magnesium. Remember, the heart contains the highest amount of magnesium in the body, so the more magnesium deficient you are, the more your heart will suffer. Any pain killer—any medication, in fact—will deplete the body's magnesium stores. Such a deficiency will only cause more migraine symptoms and magnesium

deficiency symptoms, the worst being cardiovascular problems.

Magnesium can be a safe and effective treatment for migraine. My hero in migraine therapy is Dr. Alexander Mauskop, the founder and director of the New York Headache Center. He has had enough clinical success and published enough papers on treating migraine with magnesium to title his latest paper "Why All Migraine Patients Should Be Treated with Magnesium."[8]

Dr. Mauskop believes that "all migraine sufferers should receive a therapeutic trial of magnesium supplementation." As he explains, "A multitude of studies have proven the presence of magnesium deficiency in migraine patients." Doubleblind, placebo-controlled trials have produced mixed results, but, as Dr. Mauskop writes, this is "most likely because both magnesium deficient and non-deficient patients were included in these trials." Clearly, if researchers wish to show that magnesium deficiency is a cause of migraine, it's important to test for magnesium deficiency beforehand; otherwise, the result is a seriously flawed study.

Dr. Mauskop agrees with my statements in Chapter 16 that we do not have a readily available reliable test to determine magnesium deficiency. He is right when he states that serum magnesium levels are entirely inaccurate. As he notes, the magnesium RBC test is more reliable. On this page, I recommend that everyone get their magnesium RBC levels measured. The test is available to the public at a very reasonable cost of $49.

Unlike other research papers that hem and haw when it

comes to conclusions, Dr. Mauskop's paper concludes: "Considering that up to 50% of patients with migraines could potentially benefit from this extremely safe and very inexpensive treatment, it should be recommended to all migraine patients."

Where Dr. Mauskop and I disagree is on the matter of specific magnesium supplements. He advises 400 mg of magnesium oxide daily. As I discuss on this page under the heading "Types of Magnesium," absorption studies show that only 4 percent of a dose of magnesium oxide is absorbed. Dr. Mauskop recommends magnesium aspartate, but as I note on this page, Dr. Russell Blaylock advises against magnesium aspartate.

I asked Dr. Blaylock for an update on this recommendation. He still suggests that people not use magnesium aspartate (or magnesium glutamate, for that matter). He says even though the concentration of aspartate is low, there is some evidence that it "can be high enough to trigger its excitotoxic effects—precipitating migraines. Those with neurological disorders certainly should avoid them." Dr. Blaylock cautions that some studies seem to indicate that magnesium aspartate offers neuroprotection, but he thinks that is only because the magnesium, which is in a much higher concentration, overrides the toxic effect of the aspartate.

Dr. Mauskop is so convinced of the efficacy of magnesium that he urges that if the initial dose is ineffective, patients should look for magnesium deficiency symptoms. He suggests doubling the dose if a patient has cold extremities, premenstrual syndrome, or leg or foot

cramps. He does note the limitation of diarrhea and abdominal pain due to magnesium's laxative effect; his option for patients who are unable to tolerate oral magnesium is regular IV magnesium.

Since IV magnesium is very expensive and inconvenient, I recommend ReMag, the picometer-ionic form of magnesium. I've seen perform as well as IV magnesium because it's 100 percent absorbed at the cellular level, and it has no laxative effects. I also recommend migraine sufferers get their magnesium RBC test done; the optimum level is 6.0–6.5 mg/dL.

TESTING FOR MAGNESIUM DEFICIENCY

On this page, I expose the serum magnesium test as a highly inaccurate assessment of total magnesium status. Here's why. Magnesium must remain at an effective level in the blood to keep the heart beating properly. To maintain this crucial balance, when serum magnesium levels drop, magnesium is pulled out of bone and muscle to fill the gap. Since doctors don't recognize this biofeedback mechanism, they think that serum magnesium is always normal, so they don't even bother testing for it on a normal electrolyte panel, instead looking only at sodium, potassium, calcium and chloride.

For this reason, in previous editions, I offered a list of 100 factors that can cause magnesium deficiency, in order to help people judge their level of deficiency. You can find that list starting on this page. These factors contribute to your magnesium burn rate (a term coined by fellow magnesium enthusiast Morley Robbins).

The best measure of magnesium levels in the body is the Ionized Magnesium Test, but it's mostly used just in research. I've given up trying to lobby labs to use the test; until it is available, I'm now recommending the magnesium RBC test, which measures the magnesium level in red blood cells. I began recommending the test to people who wanted to know more about their magnesium levels based on a study showing that children with ADHD have low magnesium RBC levels and normal serum magnesium levels. When the children received supplements with magnesium along with vitamin B_6 (as a cofactor for magnesium absorption), the magnesium RBC levels were

restored to normal and the children's behavior improved.[9]

The magnesium RBC test is more accurate than the serum magnesium test and it can be obtained readily over the Internet if your doctor won't write you a requisition for it. Go to www.RequestATest.com or www.DirectLabs.com and type in "magnesium RBC." You will be asked for your zip code and sent to a local lab for a blood draw. You will receive your results within seventy-two hours.

The range of magnesium RBC levels in our very magnesium-deficient population is usually around 4.2–6.8 mg/dL. You want to aim for the optimum level of 6.0–6.5 mg/dL, which is at the higher end of the normal range. Repeat the test every three to four months and use it as a guide for the form of magnesium you should take and how much. Read "How Much Magnesium Should I Take" and "What Magnesium Should I Take?" for more guidance, both on this page.

Here are the normal ranges for magnesium RBC testing using three different measurements that are commonly used worldwide.

Magnesium Test	mg/dL	mmol/L	mEq/L
Mg RBC	4.2–6.9	2.4–2.57	3.37–5.77

If your test results come back in mmol/L, multiply that result by 2.433 to give you the result in mg/dL. Note: Do not take magnesium the day of your test.

HOW MUCH MAGNESIUM SHOULD I TAKE?

Some practitioners say to take magnesium until you get diarrhea and then back off one dose. However, on the basis of this recommendation, I and millions like me wouldn't be able to take any magnesium, so it can't be used as a guideline. As noted above, I recommend you get a baseline magnesium RBC test and then repeat it every three to four months, aiming for the optimum value of 6.0–6.5 mg/dL.

It may take up to a year to build up your magnesium stores in your muscles and bones. It's important to have extra magnesium in storage for those stressful times that nobody can predict. When your stores are replete and you are no longer magnesium deficient, even the nonlaxative ReMag will give you a laxative effect if you double or triple your intake. Read the section "The Fail-Safe of Magnesium" on this page so you understand the body's built-in mechanism to prevent magnesium from becoming toxic in your body.

Having said that, I must register an official disclaimer that I can't be responsible for someone who takes copious amounts of magnesium without doing proper testing, and who takes it in spite of the four contraindications described on this page.

WHICH MAGNESIUM SHOULD I TAKE?

The past decade has seen an incredible escalation in the number of new magnesium supplements trying to gain market share. I describe the various forms of magnesium on this page, and everything I say there is still valid. However, to that list you can add plant-based magnesium and a product that I brought to market, ReMag (picometer-ionic magnesium).

PLANT-BASED MAGNESIUM

People ask me if they can get enough magnesium from plants in their diet or whether there are plant-based supplements that would work. I say perhaps. But one of the brands I recommend has only 30 mg of magnesium per tablet. I personally would have to take about twenty tablets a day to get a therapeutic level. However, when I've tried plant-based magnesium, it gives me a laxative effect at only one or two pills, so I know it is not 100 percent absorbed. And according to some research that my friend Morley Robbins dug up, absorption is highest from animal sources, not plant sources.

PICOMETER MAGNESIUM: REMAG

In the second edition of *The Magnesium Miracle* I shared my extreme reaction to magnesium pills and powders, which immediately give me the laxative effect. In order to treat my heart palpitations and leg cramps I had to apply magnesium oil to my skin several times a day and take an Epsom salts bath every day. However, in the past several years I've found an ionic form of magnesium called ReMag that is completely absorbed at the cellular level because of its picometer size. The maximum absorption for most other forms of magnesium is 20 percent; magnesium oxide, for example, is only being absorbed at 4 percent. Magnesium oxide also is a very strong laxative for many people, including myself; however, I can take three to four times the average dose of ReMag before I get that effect.

I know my personal bowel tolerance for magnesium is not "scientific" evidence, but until someone puts forth the funding to do absorption studies we are all forced to do our own personal experiments. Fortunately, magnesium is a very safe mineral for you to take.

MY FAVORITE MAGNESIUM SUPPLEMENTS

For the following supplements, you can take the suggested dosage on the label. Or you can gauge your symptoms from the list of 100 factors that indicate magnesium deficiency beginning on this page. The best suggestion is to adjust your dosage according to the results of your magnesium RBC test, striving for that optimum level of 6.0–6.5 mg/dL.

1. ReMag is a picometer-size, liquid ionic form of magnesium in 8-ounce bottles. The average daily dosage is 1 teaspoon, which is equal to 300 mg. But take it in doses of ½ teaspoon twice a day. This may seem like a low dose, but because ReMag is 100 percent absorbed at the cellular level, it's much more effective. ReMag causes no laxative effect.
You can swish ReMag in an ounce of water around in your mouth for healthy gums and immediate absorption, but do this only if you have no mercury-containing amalgam fillings. Mercury reacts with other metals and minerals, and this can create a metallic taste.

2. Natural Calm is powdered magnesium citrate sweetened with organic stevia and one of the most common oral forms of magnesium. If you get a slight laxative effect with it, just space out your doses. You can mix this magnesium powder in water and sip throughout the day for a tasty drink. If you get the laxative effect in spite of all that, or if you have not reached a therapeutic effect or the optimum level of

magnesium on your magnesium RBC test, add ReMag.

3. JigSaw Magnesium SRT is the only chelated form of magnesium that I recommend. Chelation is supposed to offer superior absorption, but the only one that seems to deliver is JigSaw Magnesium because of its sustained-release technology. It comes in capsule form, but you still must be careful to spread out your daily dosage, because even though it is advertised as having little laxative effect, I for one still get this effect from it, so I know I don't absorb it completely. JigSaw's magnesium is derived from dimagnesium malate. If you read about magnesium malate on this page, you will see that the malate part of the compound is beneficial in treating fibromyalgia. Both malate and magnesium provide necessary components for the production of the ATP energy molecules that give our body life and spark.[10]

4. Ancient Minerals Magnesium Oil is a supersaturated magnesium chloride dissolved in distilled water. When sprayed on the skin, it bypasses the intestines and is absorbed into the tissues of the body. It also stimulates DHEA production, which occurs underneath the skin. Ancient Minerals Magnesium Oil is tested to ensure it is free of mercury and heavy metals. It may sting a bit at full strength. Feel free to dilute it with distilled water or body lotion. It makes an excellent massage oil and also comes as a gel and lotion. One lotion form is called Magnesium Lotion Ultra, which contains added MSM (a sulfur compound).

If you want to treat a sprain, strain, or other injury, spray magnesium oil on the affected area, let it dry, then spray again. Several applications will often settle down any pain you have.

It's important to note that when you put magnesium oil on your skin, you cannot be sure how much magnesium you are getting or how much you are absorbing. One teaspoon is supposed to contain about 2,500 mg of magnesium. Since every spray mechanism can be slightly different, to find out how many sprays are in 1 teaspoon, you would have to count sprays into a closed container and measure.

5. I've heard from people who are using magnesium in off-label ways that I've never thought of.

a. A reader suggested 1 teaspoon of Epsom salts mixed with 1 gallon of water in a humidifier. She used it to help with COPD and allergies. (Be sure to use USP-grade Epsom salts to avoid contamination, or use 1 teaspoon of ReMag.)

b. Using a dropper, put 7–8 drops of ReMag in your ear to help with tinnitus and deafness that may be due to calcification.

c. Spray ReMag, at full strength or diluted in water, on skin. Let dry and spray again. Several applications are often enough for pain relief. ReMag is less sticky than magnesium oil.

d. Spray ReMag on your toothbrush, with or without toothpaste, for oral health.

e. Put 1 teaspoon of magnesium oil or ReMag in

a jar of facial mask to enhance circulation, detox, and healing.

THOUGHTS ON MAGNESIUM L-THREONATE (MAGTEIN)

Every week I'm asked about a new magnesium L-threonate product. Magtein is a sugar acid, threonate, bound to magnesium. The January 28, 2010, issue of *Neuron* published a paper titled "Enhancement of Learning and Memory by Elevating Brain Magnesium."[11] The study was done on rats, and researchers said that "Our findings suggest that an increase in brain magnesium enhances both short-term synaptic facilitation and long-term potentiation and improves learning and memory functions." The study compares several different forms of magnesium for absorption into the cerebrospinal fluid and found that Magtein measured only 7 percent higher at day 24 of intake. They admit that threonate by itself does not have "any positive effect on memory."

With this 7 percent increase in the CSF, promoters of Magtein say theirs is the only magnesium that crosses the blood-brain barrier. That is an inaccurate statement. Giving superpowers to their product obscures the reality that any magnesium could produce some or all of these same effects. The treatment of migraines, seizures, strokes, head injuries, and other nervous system problems with even the highly unabsorbed magnesium oxide (at 4 percent) shows that all magnesium works at the neuron level, which means all or part of it gets into the brain. See the twenty-four chapters in *Magnesium in the Central Nervous System* on page lxxxiii for more evidence.

Personally, when I take Magtein, I get the laxative effect, which means to me that it's not fully absorbed at the cellular level like some other forms of magnesium. Three

capsules of Magtein gives you 144 mg of magnesium. I would have to take about twenty capsules a day to meet my magnesium requirements. And I wouldn't get the therapeutic effect before developing diarrhea. From a quick Google search, Magtein is a patented product, so this animal study is being used to promote the product. Therefore every opportunity is used to say it's better than the competition, making people feel that if they don't take this one, they are not getting any benefit from the others. In August 2013, I heard from a supplier of Magtein that "There has been a vendor price increase, up to 400% for magnesium threonate." The research must be paid for, to create the demand and then raise the price is a standard marketing practice.

SUMMARIZING MAGNESIUM TESTING AND MAGNESIUM SUPPLEMENTATION

It doesn't matter which supplement you choose; I actually prefer that you use a combination, both orally and on your skin. Keep track of your supplementation with magnesium RBC testing. If at all possible, get a baseline test before you start heavily supplementing with magnesium, and follow your progress by retesting every three months.

Don't think you have to take enormous doses to get your magnesium saturation levels up overnight; go slowly, and read the section "When Magnesium Makes Me Worse" on this page. It's not magnesium that can make you feel worse, but often a tired or toxic body that you don't want to push too hard. You want to allow your body to gradually overcome the toxicity induced by lack of magnesium and gently wake up the hundreds of metabolic processes that depend on this valuable mineral.

THE FAIL-SAFE OF MAGNESIUM

Our bodies have a fail-safe mechanism that prevents us from absorbing too much magnesium. If we consume too much magnesium in our diets or from supplements, the body rids itself of the excess through diarrhea. This built-in fail-safe makes magnesium, in my opinion, one of the safest nutrients you can take.

Let's look at calcium, the mineral that lives in a delicate balance with magnesium. Eons ago calcium was much less available. There were no dairy cattle providing milk to make cheese and butter, no calcium-fortified orange juice, and no calcium supplements. So the ever-adaptable human body created mechanisms to grab on to and hold as much calcium as possible. That is one of the functions of vitamin D—to grab calcium and pull it into the bloodstream. Read more about vitamin D in the section "High-Dose Vitamin D Depletes Magnesium" on this page.

THE FAILURE OF CALCIUM

I talk about the "dance" of calcium and magnesium on this page, but one of the most important reasons for this third edition of *The Magnesium Miracle* is to extend the conversation into the evolving "dance competition" between these two important minerals. It's finally been proven that calcium supplements can increase the risk of heart disease. However, researchers simply blame calcium without realizing that it's the imbalance of calcium and magnesium that's actually causing the problem. It's not sufficient to just stop supplementing with calcium. We must supplement with magnesium.

Four studies published in several prestigious journals between 2008 and 2013 by lead author Dr. Mark Bolland provide evidence that an excess of calcium produces an increased risk of heart disease in women.[12],[13],[14],[15] To really impress upon you the importance of this research and the conclusions that many doctors have not yet embraced, I'll include the abstract from Dr. Bolland's fourth paper, "Calcium Supplements and Cardiovascular Risk: Five Years On."

> Calcium supplements have been widely used by older men and women. However, in little more than a decade, authoritative recommendations have changed from encouraging the widespread use of calcium supplements to stating that they should not be used for primary prevention of fractures. This substantial shift in recommendations has occurred as a result of

> accumulated evidence of marginal anti-fracture efficacy, and important adverse effects from large randomized controlled trials of calcium or co-administered calcium and vitamin D supplements. In this review, we discuss this evidence, with a particular focus on increased cardiovascular risk with calcium supplements, which we first described 5 years ago. Calcium supplements with or without vitamin D marginally reduce total fractures but do not prevent hip fractures in community-dwelling individuals. They also cause kidney stones, acute gastrointestinal events, and increase the risk of myocardial infarction and stroke. Any benefit of calcium supplements on preventing fracture is outweighed by increased cardiovascular events. While there is little evidence to suggest that dietary calcium intake is associated with cardiovascular risk, there is also little evidence that it is associated with fracture risk. Therefore, for the majority of people, dietary calcium intake does not require close scrutiny. Because of the unfavorable risk/benefit profile, widespread prescribing of calcium supplements to prevent fractures should be abandoned.

I want to emphasize the fact many more diseases than just heart disease have at their core an excess of calcium. Dr. Bollard mentions kidney stones and acute GI events as well as an increased risk of stroke. I widen the scope to include

calcium as a direct cause of inflammation. Any disease ending in -itis means an inflammatory condition, which in turn means magnesium deficiency.

Diane Feskanich also found that too much calcium can cause some forms of arthritis, kidney stones, and osteoporosis, in addition to calcification of the arteries (leading to heart attack and cardiovascular disease).[16] This study, published in the *American Journal of Clinical Nutrition*, reported that neither milk nor a high-calcium diet appears to reduce the risk of hip fractures.

Three hormones—parathyroid hormone, calcitonin, and vitamin D (which is a hormone)—are involved with the level and location of calcium in the body. Furthermore, all three of these hormones depend on magnesium for their activation and regulation.

The body doesn't take the threat of excess calcium lying down. Dr. Guy Abraham details how the body protect itself.[17]In order to protect the fluid inside the cell from becoming saturated with calcium, there is a magnesium-dependent mechanism that shunts calcium into the mitochondria. However, if too much calcium is taken for too long, the excess calcium in the mitochondria inhibits ATP synthesis. Mitochondrial calcification without the intervention of sufficient magnesium eventually results in cell death.

I've always been wary of calcium supplements, and I went out on a limb when I wrote in the previous editions of *The Magnesium Miracle* that there should be equal parts of calcium and magnesium in supplements (a ratio of 1:1). Back in the late 1990s when I was reading everything I

could about magnesium, there was an unexplained consensus that you had to take 2 milligrams of calcium for every milligram of magnesium. This 2:1 ratio was evident on most calcium-magnesium supplements and in every health book and article I picked up.

I traced this 2:1 calcium to magnesium ratio back to a 1989 report in the journal *Magnesium Research* by the famous French magnesium scientist Dr. Jean Durlach.[18] What he actually said was to never exceed the 2:1 ratio of calcium intake from all sources (food, water, and supplements). This was obviously misunderstood as a recommendation to take supplements in a 2:1 calcium-to-magnesium ratio.

Calcium excess coupled with magnesium deficiency only exacerbates the symptoms of calcification. As I mention on this page, the average diet today has a shocking 10:1 ratio of calcium to magnesium. I've described this ratio as a walking time bomb leading to impaired bone health and heart disease. To reiterate, an ideal dietary ratio is 1:1.

Calcium-to-Magnesium Ratios

Seawater	1:3
Squash	1:1
Milk	7:1

Yogurt	11:1
Calcium-fortified Orange juice	27:1
Antacids	100:1

Note that I'm saying there should be a 1:1 radio of calcium to magnesium not just in supplements but in the combination of diet, water, and supplements. Also, I feel that we can get most of our calcium from food. Therefore, it's only magnesium we need to supplement. In some cases people have to take twice the amount of magnesium as calcium to undo damage from calcium buildup, drug intake, stress, and consequent inflammation in the body.

While I was in the midst of writing the new edition of *The Magnesium Miracle*, a woman told me about her husband's experience with his doctor that illustrates my point and also offers a bird's-eye view of how little doctors know about using magnesium in clinical practice.

> My husband just had his yearly physical at the VA hospital. His physician asked what supplements he was on. We told her magnesium, calcium, and potassium (500 mg per day of both calcium and magnesium and 99 mg potassium) and an additional 250 mg of

magnesium per day in another tablet.

The doctor asked why he was taking these supplements, and I told her that research shows they will help with his high blood pressure (now under control), restless leg syndrome (gone), back pain (still working on this), and other health problems. She said he should not be taking any of them and they could be dangerous if he got too much!

His magnesium and potassium were tested and the doctor said they were both high and he should stop taking them. In your book, however, you mention that the normal magnesium blood tests usually show inaccurate amounts of magnesium, especially if the patient has other stress factors and ailments, which my husband does. Do you have any other suggestions of how to find out his true level of magnesium? Do you think he truly is getting too much of these, or could it be just inaccurate testing?

I wrote and told her to obtain a magnesium RBC test, either at the VA hospital or at RequestATest.com. I pointed out that the range is considered to be 4.2–6.8 mg/dL but that this is the average range for a population that's at least 80 percent magnesium deficient. The optimum level, I stressed, is 6.0–6.5 mg/dL.

The VA probably did the serum magnesium test, and getting a result of high levels from that test is a good thing. The magnesium in serum has to be in a very tight range to

keep the heart beating properly. If the serum magnesium level goes down, the body immediately responds by pulling magnesium out of storage in the bones or muscles and puts it into the blood.

However, high calcium in the blood is not so good, and I told her that I don't recommend calcium supplements. Too much calcium means your magnesium has to neutralize that supplement before doing its work in the body. (The accuracy of calcium testing is actually quite high.)

I received a very appreciative email back in which the woman admitted that she was frustrated that the VA doctor refused to recognize that a lot of her husband's symptoms were from magnesium deficiency. The woman said at one point she became really confused and wondered if she should listen to the VA doctor and stop her husband's magnesium. But when she reread *The Magnesium Miracle* and website articles, she was convinced that the doctor just didn't know enough about magnesium and that if her husband went off magnesium his ailments would only get worse.

The woman did ask why I was recommending against calcium supplementation when I had suggested in my book that patients should take 500 mg calcium along with 750 mg of magnesium. I explained those recommendations were from six years ago, before all the research showing that calcium supplements can cause heart disease. I told her that at that very moment I was working on the third edition of *The Magnesium Miracle* so I could set the record straight about calcium and heart disease and change my recommendations.

In a March 2012 press release from the nonprofit Nutritional Magnesium Association (where I sit on the Medical Advisory Board), titled "High Calcium–Low Magnesium Consumption Poses Health Risk," I quoted the National Institutes of Health's "2011 Dietary Supplement Fact Sheet on Calcium," which stated that 43 percent of the U.S. population (and 70 percent of older women) take calcium supplements. However, the NIH says that less than half of that calcium is absorbed in the gut; the rest is either excreted through the large intestine, causing constipation, or through the kidneys, potentially forming kidney stones. Or it is transported to other soft tissues, where it can harden (calcify) into gallstones, heel spurs, atherosclerotic plaques, fibromyalgic calcifications, and breast tissue calcifications.

What the NIH fact sheet does not say is that magnesium in adequate amounts is essential for the absorption and metabolism of calcium and vitamin D. Magnesium converts vitamin D supplements or vitamin D in storage form (calcidiol) into its active form (calcitriol), which can be absorbed in the gut. Magnesium also activates the hormone calcitonin, which helps to preserve bone structure and draws calcium out of the blood and away from soft tissues and into the bones. This necessary action lowers the risk of osteoporosis, some forms of arthritis, heart attack, and kidney stones. Read the section "High-Dose Vitamin D Depletes Magnesium" on this page.

Most people, including MDs, do not understand the importance of balancing calcium and magnesium at the cellular level. Calcium cannot build bones or prevent

osteoporosis without adequate levels of magnesium. It's as simple as that. If our bones are made entirely from calcium, they become brittle and can shatter, just like a stick of chalk falling on the sidewalk. However, with the right percentage of magnesium, bone has the proper density and matrix that actually makes it flexible and more resistant to shattering. I'm afraid many elderly people are suffering bone fractures because they have too much calcium and not enough magnesium.

CALCIUM EXCESS CAUSES INFLAMMATION

Calcium overload is also one of the main causes of inflammation in the body. Inflammation is an important topic in the earlier editions of *The Magnesium Miracle*. But I didn't emphasize enough that calcium is a major cause of inflammation, and that magnesium is a key anti-inflammatory because you can neutralize calcium with magnesium, dramatically reducing your levels of inflammation.

The FDA and drug companies are aware of the importance of treating inflammation, but regrettably they are using drugs, with all their side effects, as the primary treatment instead of recommending magnesium. Even worse, anti-inflammatory steroids and many nonsteroidal anti-inflammatory drugs are often fluoride compounds, which means they bind up magnesium. Treating inflammation with ineffective and unsafe drugs inevitably creates more inflammation.

Where is all this calcium coming from? Recommendations for calcium intake vary greatly. In the United States, women over fifty are told by doctors and health publications to take up to 1,500 mg. However, in the United Kingdom, the RDA is set at 700 mg daily, while the World Health Organization recommends only about 500 mg.

When hospital osteoporosis clinics advise 1,500–2,500 mg of calcium, they don't consider the amount that people are already getting in their food or water. Many people, especially those consuming dairy products, have very high-calcium diets. This can lead to escalating amounts of

unabsorbed calcium.

Food and water have higher amounts of calcium than magnesium, as mentioned on this page. The standard American diet approaches a 10:1 calcium-to-magnesium ratio. Levels of all minerals have been diminishing because farmers don't use mineral fertilizers and because many of the chemicals used as herbicides and pesticides bind up minerals, especially magnesium. However, the amount of calcium in the soil is still higher than that of magnesium

You can find a list of the amount of calcium in common foods in the Appendix on this page. You'll see that a mere 7 sardines (with bones), half a can of salmon (with bones), or 20 oysters give you between 284 and 393 mg of calcium. A cup of bok choy nets you 252 mg.

When someone tells me they don't eat dairy, I send them a recipe for bone broth, something your grandmother probably made all the time. I've included a basic bone broth recipe on this page. You can find more recipes for chicken, beef, and fish bone broth by searching the Weston A. Price website. It's difficult to determine the actual number of milligrams of calcium in a serving of bone broth, as every batch will be different, but taking it along with several servings of high-calcium vegetables, nuts, seeds, cheese, and fermented dairy (yogurt, kefir) will more than cover your daily requirements for calcium.

I've proven to myself the power of calcium in the diet. When I go on a yogurt and goat cheese binge, I'll begin experiencing some of my old heart palpitations and know that I need more magnesium to balance the extra calcium in my diet.

MAGNESIUM AND OSTEOPOROSIS

I was curious to see what the 2013 guidelines from the National Osteoporosis Guideline Group (NOGG) would suggest for osteoporosis therapy in light of the connection between calcium and heart disease that I discussed above. I was very disappointed, however. There is no mention of magnesium, and although calcium was downplayed, that just meant there will be much more drug intervention in women's bone health. The significance of magnesium in bone health cannot be underestimated, yet it is overlooked every day in most doctors' offices.

NOGG published its recommendations in the June 17, 2013, issue of *Maturitas*. They began with a list of the main drugs that claimed to lower the risk for vertebral fracture (and for hip fracture in some cases). These include bisphosphonates, denosumab, parathyroid hormone peptides, raloxifene, and strontium ranelate. The report acknowledged the danger inherent in these drugs, as it:

1. Cautioned against mixing two or more of these drugs together because of unknown side effects
2. Mentioned the high cost of some of the drugs
3. Warned that withdrawing bisphosphonates (Fosamax) is associated with rebound decrease in bone mineral density and bone turnover. This implies that once you are on Fosamax you should stay on it forever or else experience even more bone loss and deterioration.

At the bottom of the report were the guidelines about

calcium and vitamin D. It read: “Calcium and vitamin D supplementation is widely recommended for older persons who are housebound or live in residential or nursing homes and is often recommended as an adjunct to other treatments for osteoporosis.” And then came a caveat: “Potential adverse cardiovascular effects of calcium supplementation are controversial, but it may be prudent to increase dietary calcium intake and use vitamin D alone rather than using both calcium and vitamin D supplementation.”

There was no mention of magnesium anywhere in the guidelines. Neither did they mention testosterone, which is a known bone builder in men and also in women. However, you don’t have to rush into the unknown world of synthetic hormones just yet. A 2011 study found that in a group of 399 older men, magnesium levels are strongly and independently associated with testosterone and another anabolic hormone, insulin growth factor-1 (IGF-1).[19] Any increase in testosterone will automatically increase estradiol since it comes after testosterone in the natural steroid pathway of the adrenals and sex glands.

Why am I so concerned about the inappropriate treatment of osteoporosis? The most recent statistics on osteoporosis incidence are for the years 1984–1993, showing that the incidence of the disease rose an alarming 700 percent in that decade.[20] How is that even possible when we have led a war on osteoporosis for so long? The answer is that we chose the wrong weapons, and now even those weapons have turned against us.

MAGNESIUM MORE IMPORTANT THAN CALCIUM IN CHILDREN'S BONES

I've often heard parents exclaim, "How can my kids get calcium for their bones if they don't eat dairy products?" But not once do they ask about magnesium. Finally, a new study shows that the amount of magnesium consumed and absorbed is *the* key predictor of children's bone health. The researchers found that intake of dietary calcium was not significantly associated with total bone mineral content or density.

A 2013 study presented at the annual meeting of the Pediatric Academic Societies in Washington, DC, validates magnesium's vital importance. This study confirms that magnesium works synergistically with calcium. Magnesium regulates the proper amount of calcium in a child's body and marches it straight into the bones. Calcium, if it is not balanced with magnesium, ends up depositing in a child's kidneys, coronary arteries and cartilage, not in the bones, where the child needs it most.

Steven A. Abrams, MD, FAAP, professor of pediatrics at Baylor College of Medicine in Houston, said, "Calcium is important, but, except for those children and adolescents with very low intakes, may not be more important than magnesium."

For researchers to boldly state that calcium "may not be more important than magnesium" is a huge breakthrough in helping people grasp the importance of magnesium in bone health. Until now, it's been all about calcium. I just hope that prescription will also be given to adults.

MAGNESIUM AND MENOPAUSE

At a time when most menopausal women are only told to take calcium supplements, the following testimonial offers great hope. A reader of my blog wrote to me about her experience with magnesium and menopause. She said that in her research she found that most of the thirty-four symptoms of menopause are actually identical to the symptoms of magnesium deficiency. So she put herself on a magnesium supplementation regime.

Within three days she began to feel more normal. Her daytime hot flashes had dropped from twenty or so a day to fewer than ten, and they were milder. Her episodes of night sweats fell from more than ten per night to three or fewer. Her insomnia disappeared and her terrible anxiety, rapid heartbeat, and depression all started to fade away, as did skin-crawling sensations and aches and pains. Having suffered progressively with worsening symptoms since entering menopause three years prior, she said that ten days after starting supplementation she was basically symptom free. She ended by saying, “Magnesium is a miracle, and everyone, particularly menopausal women, should be made aware of it.”

Unfortunately, when women of menopausal age are prescribed calcium and no magnesium, their menopausal symptoms can become worse.

TREATING MAGNESIUM LIKE A DRUG

In the past few years I've noticed a mushrooming of medical websites that have decided to treat vitamins and minerals like drugs. Since they aren't drugs and don't act like drugs, and since drugs, by definition, have side effects, such misinformed websites give people the impression that supplements can have side effects and can be dangerous. This is very confusing to the consumer and contrary to the evidence. In 2003, I wrote a paper called "Death by Medicine" and then a book called *Death by Modern Medicine: Seeking Safe Solutions* wherein I enumerated statistics about iatrogenesis (illness caused by medical treatment) for medicine and for supplements. Here are some of the findings.

The *Journal of the American Medical Association* reported that between 90,000 and 160,000 deaths per year occur from using FDA-approved drugs, making drugs the fourth-most-common cause of death. That figure doesn't include medical and surgical mistakes or preventable deaths.[21] (Very sadly, the researcher who reported these findings, Dr. Barbara Starfield, herself died in 2011 when the blood-thinning drugs she was taking caused a fatal brain hemorrhage.)

By comparison, dietary supplements have averaged fewer than five confirmed deaths per year over the past twenty-five years in the United States. Most of those deaths relate to a single batch of tryptophan, laced with a genetically engineered component, that was sold in the late 1980s.

Lance Armstrong, the founder of the website Livestrong,

is no stranger to drugs, and his site promotes an allopathic look at health. Someone wrote that she found the following on the Livestrong website:

> Magnesium toxicity results when your body absorbs more magnesium than it can use or excrete.... [T]aking too much supplemental magnesium can result in symptoms of toxicity. These symptoms include a fall in blood pressure, confusion, abnormal cardiac rhythm and deterioration of kidney function. Individuals can also experience muscle weakness and difficulty breathing. People who have kidney trouble are at a higher risk from supplemental magnesium intake and should not take any over-the-counter supplementation without first consulting with their physicians.

The above warning is very misleading. It's not that "taking too much supplemental magnesium can result in symptoms of toxicity." That statement implies that magnesium toxicity can occur in anyone. That's really not the case. The very few reports of magnesium "toxicity" are in hospitalized patients put on IV magnesium. Unfortunately, these reports get repeated inappropriately in the media. The reality is that there are only certain people with serious health conditions, who are usually already under a doctor's care, who are warned not to take magnesium. There are only four contraindications to magnesium therapy: kidney failure, myasthenia gravis, excessively slow heart rate, and bowel obstruction. You can read more

details on this page.

Other websites will talk about magnesium's side effect of diarrhea, not understanding that this is the body's mechanism for avoiding a buildup of magnesium. But diarrhea can also happen when anyone takes a large amount of magnesium at one time, causing a relative overload. Read about "The Fail-Safe of Magnesium" on this page. The laxative effect can also happen in people like me who have an irritable bowel, but there are safe nonlaxative forms of magnesium that you can take. Read about picometer magnesium on this page.

The University of Maryland posted an article on its website called "Possible Interactions with Magnesium." It seems intent on making you afraid of magnesium. The article warns people not to use magnesium if they are also taking antacids, laxatives, fluoroquinolone antibiotics, calcium channel blockers, or medications for diabetes. But these warnings make no sense because magnesium is a natural calcium channel blocker; the fluoride in fluoroquinolones binds with magnesium, making it unavailable; and magnesium deficiency is a medical sign of diabetes. In fact, I warn my clients about taking any of the drugs in the above list, and if they must, to double or triple their intake of magnesium to counteract the magnesium drain.

The tendency for medical and government sites to medicalize nutrients and categorize them as drugs playing up rare and sometimes imaginary side effects comes, I believe, from an organization called Codex Alimentarius. Codex, run by the World Health Organization and the

World Trade Organization, sets the standards for food and dietary supplements that are being shipped around the world. The pharmaceutical companies have a great interest in Codex; their intent is to make sure that nutrient levels are not high enough to be therapeutic, so they will not "interfere" with prescribed medications. Ultimately they want nutrients to be treated like drugs and only prescribed by doctors. Many people who take magnesium have been successful in reducing or even eliminating their intake of medications, which can't please pharmaceutical companies.

When I attended a nutrition seminar hosted by the National Center for Complementary and Alternative Medicine at the National Institutes of Health, one of the speakers said the NIH mandate was to issue guidelines on the RDA (Recommended Daily Allowance) for nutrients only to prevent deficiency diseases—like how much vitamin C it takes to prevent scurvy and that the NIH had no interest in supplements for the prevention and treatment of disease. Unfortunately, doctors learn nothing about magnesium and other nutrients in medical school. Because they only know what they have been taught, they fear what they don't know, and so it's easier for them to box magnesium into the drug category

MORE MAGNESIUM MISINFORMATION

There are hundreds of ways that our bodies utilize magnesium. Because science can't identify one of those as *the* most important factor, magnesium is ignored. But this approach of looking for a single factor is based on the medical model of "one symptom, one diagnosis, one drug." Science depends on this model to isolate one variable at a time for scientific testing. It would be impossible to limit a food nutrient such as magnesium in that way, since it is involved in as many as eight hundred enzyme systems, affects 80 percent of the body's biochemistry, and interacts with dozens of other nutrients.

There are stacks of papers from researchers all over the world proving the value of magnesium. However, the one thousand research papers written by the doctors who wrote the foreword to this book, Drs. Burton and Bella Altura, unfortunately did nothing to make the public aware of magnesium's importance.

As I say on this page of *The Magnesium Miracle*, we can't wait for a multimillion-dollar clinical trial to finally "prove" that magnesium is a necessary nutrient. We have enough research showing safety and efficacy, and what's more, people can do their own personal clinical trial by following their magnesium RBC test results and taking magnesium as they watch their symptoms subside.

Magnesium is safe, and people are deficient in it. For every one hundred emails I get with positive responses to magnesium, I only get one that claims a "negative" reaction. Since there *are* no negative reactions to magnesium, I make sure people read "When Magnesium

Makes Me Worse," this page.

KIDNEY DISEASE AND MAGNESIUM MISINFORMATION

Recently I've been noticing that more people are coming to me with a diagnosis of kidney disease and kidney failure. Signs of kidney disease include high blood pressure, protein on urinalysis, and an elevated glomerular filtration rate. High blood pressure is a very common cause of kidney disease. But in my opinion, the most common causes of high blood pressure are magnesium deficiency and calcium excess. Why else would doctors prescribe calcium channel blockers for high blood pressure if calcium was not a problem? Kidney patients are told to keep their blood pressure under control, but how are you going to do that if you're not "allowed" to take magnesium? Instead you are told to take blood pressure medications that drain more magnesium.

Protein in the urine is one of the earliest signs of kidney disease, especially if you also have diabetes. One of the known medical signs of diabetes is a low magnesium level. So, if you have kidney disease and you can't take magnesium, your blood sugar levels are going to keep getting higher as your magnesium gets lower.

Doctors recommend these tests be done annually to help diagnose kidney disease early, so it can be treated. And what is the medical treatment? Using medications to prevent blood pressure and diabetes. On all the medical websites I researched, there was no mention of using magnesium for the prevention and treatment of high blood pressure or diabetes. These sites make it clear, however, that kidney disease is usually progressive, ending in kidney failure and heart failure.

There is a bit of light at the end of the tunnel, however. The February 2012 issue of *Clinical Kidney Journal* included a long supplement called "Magnesium in Disease." The authors say that low serum magnesium levels are associated with metabolic syndrome, type 2 diabetes, and hypertension. They also say that some individuals benefit from magnesium supplementation, because it reduces high blood pressure, and that higher serum magnesium levels are associated with a lower risk of developing metabolic syndrome. Remember what I've said about serum magnesium before—that when it's low, the body is very deficient in magnesium. So perhaps their minds are opening.

Most doctors are told that magnesium therapy shows conflicting results. On this page, I report that the LIMIT trial found great benefits from using IV magnesium at the onset of a heart attack. However, another trial called ISIS withheld IV magnesium far past the LIMIT protocols and therefore erroneously said that magnesium didn't work compared to drug therapy. Now I see in the literature that researchers are using the ISIS trial to say that IV magnesium "cannot be recommended in patients with myocardial infarction today."[22] Unfortunately, that flawed trial will hold back widespread clinical application of magnesium for decades.

A well-known magnesium researcher asked a colleague, a kidney disease specialist, to test his patients for magnesium levels. It was agreed that ionized magnesium and serum magnesium testing be done on a hundred kidney patients. The results were that people with chronic kidney disease

(of all varieties) had both the highest levels of serum magnesium and the lowest levels of ionized magnesium. When these patients took magnesium liquid, their ionized magnesium levels improved, their serum magnesium levels went to normal, their symptoms improved, and their kidney function tests improved. When the magnesium researcher prodded the kidney specialist to publish these amazing findings, he said he could not "because everyone knows that magnesium can't be taken in kidney disease!"

This anecdote explains for me why doctors fear magnesium. They see the serum magnesium levels are elevated and assume the worst; however, they don't notice that ionic magnesium is low, showing that the cells are starved for magnesium because the magnesium can't get inside. The ionized magnesium test is a research tool and the definitive test for cellular magnesium; you can read about it on this page.

WHEN MAGNESIUM MAKES ME WORSE

When people take a supplement they have the expectation that it will make them feel better. We know that's not always the case with drugs; in fact, people seem to accept that drugs will give them side effects. But what about supplements? More people are reading my book and hearing about magnesium, and some of them are taking magnesium without supervision. A few people wonder if it can make them feel worse. There are at least a dozen reasons why you might feel "worse" after taking magnesium; I would like to explain these, and reassure you of the safety of magnesium.

1. ***You're not taking enough.*** When you feel worse with magnesium, I believe that the hundreds of enzyme systems that require magnesium are getting jumpstarted and your body simply wants more. Here's how Laura, one of my blog readers, put it: "My obvious magnesium deficiency symptoms, cramping, muscle aches, headaches, etc., are worsening slightly rather than getting better. Anxiety is the only thing that has gotten better. Is this normal? I'm using magnesium oil and magnesium citrate but not able to tolerate more than 200–300 mg without getting diarrhea."

   Laura has woken up her magnesium-dependent enzymes, and they are hungry. It's like putting your foot on the accelerator without enough gas in the tank. With each enzyme system pumping away, they quickly use up the little magnesium Laura is giving

them, and they simply want more.

This doesn't mean that you'll have to keep increasing your magnesium ad infinitum! You will reach a saturation point of magnesium stores and actually be able to decrease your magnesium intake. However, Laura isn't going to get what she needs if she gets the laxative effect on 200–300 mg. That's one of the main reasons to take ReMag—so you can get the therapeutic effect before you get the laxative effect. ReMag is absorbed 100 percent at the cellular level and has no laxative effect, so you can take as much as you require to eliminate all your magnesium deficiency symptoms.

2. ***You're taking too much.*** You can also feel worse on magnesium if you take too much too soon. This usually happens if you have fatigue and weakness from magnesium deficiency. Anyone in this category should start very slowly on any new supplement or drug. If you take a high dose of magnesium right from the start, it's as though you're giving muscles that are used to walking five minutes a day enough fuel to run a marathon. Your body might just be so weak that revving up those hundreds of enzyme systems all at once makes you feel jangled and even anxious because you don't know what's going on. For people with chronic fatigue and adrenal issues, start with one-quarter of the recommended dose of magnesium and work up as your body adapts.

3. ***You have low blood pressure from long-standing magnesium deficiency and adrenal fatigue.*** You may have heard that magnesium can

lower blood pressure, so you worry about that happening because your blood pressure is already low. This is another instance where you must begin by supplementing at about one-quarter the recommended dose of magnesium and slowly build up. The minerals offered in ReLyte electrolyte replacement supplement are important to support adrenals and thyroid and improve potassium levels. And you can use sea salt (¼ teaspoon per pint of drinking water) to help improve sodium levels; this will balance your blood pressure and support your adrenals. How much water should you drink per day? I advise half your body weight in ounces of water. So if you weigh 150 pounds, you should be drinking 75 ounces of water a day.

4. ***You're on heart medications, and as your health improves because of magnesium supplementation, your meds are becoming "toxic."*** That's because you may not require them anymore, not because magnesium is bad for you! Check with your doctor when you are using magnesium to treat health conditions, and make it clear that you want to wean yourself off your meds. For example, magnesium helps lower blood pressure. If you continue to take the same amount of blood pressure meds, your blood pressure might become too low. This is not a side effect of magnesium. It's a side effect of taking drugs when you don't need them.

5. ***You've started taking iodine or thyroid medication, or you have hyperthyroidism***. Either of these speeds up your metabolism, which can give you

heart palpitations that have nothing to do with magnesium. The key to recognizing this problem is that you also have an elevated pulse rate and the magnesium you normally use to control your heart palpitations is no longer working.

6. ***You're taking too much vitamin D***. You've been feeling great on your magnesium, and then you begin taking high-dose vitamin D and find yourself experiencing magnesium deficiency symptoms. Magnesium is required to transform vitamin D from its storage form to its active form and for many other aspects of vitamin D metabolism. That means if you take the extremely high doses that allopathic doctors are now recommending, you can plummet into magnesium deficiency and not know what is happening. For this reason I don't recommend more than 1,000–2,000 IU of vitamin D daily. And never take vitamin D without magnesium. This is such an important factor in the total magnesium picture that it deserves a separate section, "High-Dose Vitamin D Depletes Magnesium," which you can find on this page.

7. ***You are taking too much calcium and it's pushing out your magnesium***. Read about the competition between calcium and magnesium in "The Failure of Calcium" on this page to understand why calcium is now a pariah. Excessive amounts of this mineral are causing heart disease and many other symptoms of calcification in women and men who take it.

8. ***You're taking fairly high doses of magnesium and not taking trace minerals or drinking enough water.*** Trace minerals help your body hold on to water. Without them you can become dehydrated. To treat trace mineral deficiency, I recommend ¼ teaspoon of sea salt in every pint of drinking water. As I note above, I recommend you drink half your body weight in ounces of water each day. You can also take ReLyte, which will give you twelve important and necessary minerals that are absorbed directly into your cells.

9. ***You're not taking enough B vitamins.*** Vitamin B_6 and B_2 are important vitamins that assist magnesium absorption into cells. On this page I write about vitamin B_6. I mention vitamin B_2 on this page, as it is used with magnesium and feverfew in migraine therapy. A number of papers have reported on the relationship of magnesium and B_6 in the treatment of PMS. Most recently, research has been directed at the benefits of magnesium and vitamin B_6 in autism and ADHD. However, I don't recommend high-dose synthetic B_6 because of the occurrence of peripheral neuropathy in a small percentage of people. This side effect is probably due to magnesium deficiency. Instead I recommend food-based B complex. Grown by Nature brand has 2 mg of B_6 per tablet.

10. ***You are mercury toxic.*** On this page of *The Magnesium Miracle* I state, "Mercury drastically increases the excretion of magnesium and calcium

from the kidneys, which may be the cause of the kidney damage seen in mercury poisoning." Removing mercury from the body is important but not the focus of this book. Taking sufficient amounts of magnesium can help detoxify this dangerous heavy metal.

11. ***You are toxic from a bad diet, prescription medications, heavy metals, or environmental chemicals:*** As magnesium enters your cells, it stimulates internal detoxification processes and dumps chemicals from your cells into the lymphatic system. These are eventually excreted through your skin, kidneys, and colon. Toxins surfacing on the skin can cause skin irritation, inflammation, hives, and rashes. This type of reaction is not an "allergy" to magnesium but a simple detox reaction, as the body is now more able to do its job. There have only been a couple of so-called allergy reactions to magnesium. The ones I've studied were due to IV magnesium sulfate, and the reaction may actually be due either to the sulfur trying to get past blocked sulfur pathways or to the aluminum that is found in IV magnesium. Sulfur is likely the problem, because IV magnesium chloride also contains aluminum and I've not heard of so-called allergy reactions to this form of magnesium. I would advise against chronic administration of these forms of IV magnesium due to the aluminum content. ReMag is an excellent substitute for IV magnesium according to several case reports.

12. ***You're taking a drug that contains fluoride***. Read the section "Fluoride Binds Magnesium,"

immediately below, to understand why you may be susceptible to magnesium deficiency due to medically prescribed drugs.

FLUORIDE BINDS MAGNESIUM

In *The Magnesium Miracle*, on this page, I warned about the toxic chemical fluoride being increasingly used in prescription drugs, our water supply, and dental products. That warning went unheeded and fluoride products have continued to flood the marketplace.

Drug companies have found that fluoride (which is derived from fluorine) has unique properties that are ideal for prolonging the active presence of a drug in the body. Fluorine is the most electronegative element available and it can substitute for hydrogen in medicinal compounds, making the compound stronger, more stable, more acidic, and fat-loving. These qualities increase the bioavailability of the drug and its ability to attach to binding sites on cellular receptors and enzymes in the body. While the drug companies may think fluoride is magnifying the effects of the drug, it's also magnifying the number and intensity of the drug's side effects.

The trouble is that fluoride interferes with the biological activity of magnesium. Fluoride binds magnesium into an insoluble mineral called sellaite (MgF_2) that can be substituted for magnesium in bone and cartilage, but the resulting brittleness makes the bone susceptible to fracture. The bond is so tight that magnesium is irrevocably lost to the body, interfering with its thousands of biochemical interactions and decreasing enzymatic action.

On a website called Fluoride Toxicity Research Collaborative, you can click on the following common classes of drugs that contain fluoride to see the lists of specific drugs.

- Anesthetics
- Antacids
- Anti-anxiety medications
- Antibiotics
- Antidepressants
- Antifungals
- Anti-inflammatories
- Antimalarial drugs
- Appetite suppressants
- Arthritis drugs
- Antipsychotics
- Chemotherapy drugs
- Statins
- Steroids

Neurosurgeon Dr. Russell Blaylock, medical director for Second Look, a nonprofit that examines public policy on water fluoridation and fluoridated drugs, confirmed to me that people taking fluoridated drugs are at higher risk for developing magnesium deficiency and suffering severe side effects. I asked Dr. Blaylock what percentage of drugs were fluoridated, as I've heard figures ranging from 20 to 55 percent.

Dr. Blaylock said the real danger is that the most commonly used drugs include fluoride. These include Prozac, Paxil, Cipro, Diflucan, Celebrex, Prevacid, Propulsid, Lipitor, and steroids. Every day you take one of

these drugs you are robbing your body of magnesium, and magnesium deficiency symptoms such as anxiety and depression go unrecognized. Not only are you depleted in magnesium because it's not in your food, but any magnesium in your body is destroyed by fluoride in your drugs. How crazy is that—taking a drug for a problem that is made worse by taking that drug!

Fluoroquinolones, including the widely used antibiotic ciprofloxicillin (Cipro), can cause disabling tendon rupture. It's obvious to me that the brittleness that MgF_2 imparts to cartilage may be one of the reasons Cipro causes tendon rupture after an escalation of side effects that begin with muscle pain, sore joints, and muscle spasm. Cipro can also be an unrecognized cause of fibromyalgia. Magnesium is an effective treatment for the side effects of Cipro, especially when those side effects are identified within a few months of taking this drug.

The Wikipedia entry on fluorine informs us that about 30 percent of chemical weed killers and herbicides contain fluorine. Many insecticides contain sodium fluoride. Although it doesn't contain fluoride, another herbicide, glyphosate (Monsanto's Roundup), binds magnesium, removing 50 percent of what little is left in the soil. Some research suggests that Roundup can have a very long half-life, as much as twenty-two years, in the soil.

MAGNESIUM AND ELECTROMAGNETIC FIELDS

Some people insist that they are negatively affected by electromagnetic fields (EMFs) in the low-and microwave-frequency range. But until now, science has stayed neutral on EMFs, saying that the only effects from EMFs are due to heat.

EMFs can have positive effects, stimulating bone growth. A study focusing on negative effects showed that EMFs caused single-strand breaks in DNA. In fact, many people feel that EMFs can cause many side effects in the body. This condition has been labeled electromagnetic hypersensitivity (EHS), which unfortunately implies that only "sensitive" people feel these effects.

According to Wikipedia: "The reported symptoms of EHS include headache, fatigue, stress, sleep disturbances, skin symptoms like prickling, burning sensations and rashes, pain and ache in muscles and many other health problems. Whatever their cause, EHS symptoms are a real and sometimes a disabling problem for the affected persons." According to Morley Robbins, "Hypersensitivity is a sign of magnesium deficiency. EMFs are stressors, therefore they cause magnesium loss adding to our Magnesium Burn Rate."

A paper by Dr. Martin Pall reviewing twenty-three EMF studies found that the production of EMF side effects has to do with voltage-gated calcium channels (VGCCs).[23] The wide range of actions caused by EMFs are thought to be due to two different pathways for VGCCs.

Scientists don't know the cause of EHS, but when I see that voltage-gated calcium channels are involved, I

nominate magnesium deficiency as a probable cause. On this page, I discuss calcium channels and how they are jealously guarded by magnesium. Magnesium, at a concentration ten thousand times greater than that of calcium inside the cells, allows only a certain amount of calcium to enter to create the necessary electrical transmission, and then immediately helps to eject the calcium once the job is done. Otherwise, if calcium accumulates in the cell, it causes hyperexcitibility and calcification and disrupts cell function. Too much calcium entering cells can cause symptoms of heart disease (such as angina, high blood pressure, and arrhythmia), asthma, and headaches. Magnesium is nature's calcium channel blocker.

What are the main symptoms of magnesium deficiency and calcium excess? Headaches, fatigue, insomnia, muscle pain—just like EHS symptoms. My theory is that the negative effects of EMFs occur in people who are magnesium deficient, and their hypersensitivity to EMFs is because they don't have enough magnesium to block the calcium channels stimulated by EMFs. Maybe my theory will be validated in a decade or two; in the meantime, get your magnesium RBC test and begin taking magnesium to prevent upward of one hundred symptoms, including damage from EMFs.

More studies are called for, but Dr. Pall's paper does help vindicate people who feel that EMFs are operating at more than just a heat-producing level.

MAGNESIUM IN THE MEDIA

THE MAGNESOME

A recent breakthrough in basic magnesium research led to the discovery of the "human magnesome." The magnesome is a set of proteins within the complete makeup of human protein consisting of multiple binding sites for magnesium ions. Using innovative technology, researchers found that 27 percent of the human sequences studied (3,751 out of 13,689) carried magnesium binding sites. This finding shows that magnesium is in a unique position to alter the expression and behavior of human proteins and their effect on health and disease. The magnesome heralds a new wave of magnesium research and highlights the biological supremacy of this regulatory mineral.

I find the magnesome research fascinating because it helps us understand exactly why our genes are not in total control of our bodies, as we've been told. The Human Genome Project was launched to identify all the genes in the human body and ultimately match individual genes to individual diseases. Researchers were shocked to find only twenty-three thousand genes in the human body, as they had predicted they would find three times that amount. This finding can only mean that the science of epigenetics is as valid as genetics. The prefix *epi*means "around," and epigenetics is based on the idea that the environment surrounding genes turns them on or off. The most important environment surrounding genes is the cofactor for biochemical processes—vitamins and minerals.

ARRHYTHMIA AWARD

In the fall of 2012 I received the Arrhythmia Alliance Outstanding Medical Contribution to Cardiac Rhythm Management Services Award, given by the Heart Rhythm Society in the United Kingdom. Arrhythmias can be life-threatening, and the only treatment options are to learn to cope with the mild ones or treat the moderate to serious ones with drugs and surgically inserted pacemakers.

One of my personal magnesium deficiency symptoms is heart palpitations, so I know how scary and disruptive they can be. It is very distressing to actually feel your heart not working properly. But I tell people it's not that you have a heart problem; rather, your heart is just not getting enough magnesium. As I've noted, the highest amount of magnesium in the body is found in the heart.

I was quite astonished to receive this award because the Heart Rhythm Society is very science-and research-oriented. By honoring me, they are acknowledging the important role of magnesium in the treatment of arrhythmia. This award shows me that magnesium research has hit the mainstream, and there is no going back!

Let me share a couple of emails that I've received from people with arrhythmias whose lives have been dramatically improved by using magnesium.

> Dr. Dean, a few months ago I wrote to you regarding my amazing results after using magnesium to suppress PVCs (premature ventricular contractions) and PACs (premature atrial contractions). It has been almost six

months and I still wake up every morning thanking God for this mineral!

Another person who had almost given up at the age of only thirty-one wrote a long account that will resonate with many readers.

> I want to thank you so much for your book *The Magnesium Miracle*. It is no overstatement to say that it has changed my life overnight. I'm only thirty-one years old, but for over ten years I have been plagued by premature atrial contractions (PACs), premature ventricular contractions (PVCs), and tachycardia. I was told by multiple doctors that I was fine and to just go home and ignore the arrhythmias. I kept crawling back to the doctors hoping that they could offer me some solution, but all they would do is run more tests and try to put me on Zoloft.
>
> There was one year that I had more echocardiograms than haircuts! Several months ago my palpitations increased from the once-in-a-while range to several times every day. While desperately reading through some posts in an online forum I saw several people singing the praises of your book and the wonders of magnesium which had worked for them. I purchased some magnesium and after prayerfully taking my first dose four days ago I have not had a single PVC since! It's truly a

> miracle.
>
> Even though the first day after starting magnesium I was double slammed with a terrible head cold and the first day of my period, I still had zero palpitations. Ordinarily a day like that would have me kicking out PVCs like a popcorn machine.
>
> I just want to run through the streets kicking up my heels! I have already convinced half a dozen people to read your book and give magnesium a try for various ailments. This supplement has been such a blessing to me and has given me my life back. I am so glad there are people like you out there willing to point patients in a natural direction for good health. I would be honored, flattered, and proud to have you share my story. Please continue in your efforts to bring more light to this miracle.

Why aren't more doctors telling their patients with arrhythmias to take magnesium? As evidenced by the following statement in a paper written almost thirty years ago, the medical community has long known that common diuretics eliminate potassium and magnesium, leaving a person susceptible to arrhythmias.

> A significant inter-relationship between the plasma concentrations of magnesium and potassium and the evidence for a critical role of magnesium in the genesis of cardiac arrhythmias would support the proposal that

> magnesium should be routinely measured in situations, such as diuretic therapy, that are potentially associated with hypokalaemia.[24]

The paper calls for routine measurement of magnesium during diuretic therapy, but to this day that is still not done. If your doctor isn't testing you properly for magnesium, I strongly recommend that you have your own magnesium RBC test done periodically to guide your magnesium intake.

MAGNESIUM IN RECLAIMED WATER

Israel has passed legislation to add magnesium to its drinking water, which is reclaimed from the sea. I am in touch with the company that will provide the magnesium for this purpose. This is a huge breakthrough: shortly after this is implemented, we should see a decrease in deaths due to heart disease. But that's only if they don't go forward with a plan to also fluoridate that same water! See the section "Fluoride Binds Magnesium" on this page.

Just how many deaths would be prevented by fortifying water and even foods with magnesium? Paul Mason made his paper "Calculations of American Deaths Caused by Magnesium Deficiency, as Projected from International Data" available on his website, www.mgwater.com. Mason summarizes:

> Magnesium deficiency appears to have caused eight million sudden coronary deaths in America during the period 1940–1994, based on census data and studies of similar deaths from magnesium deficiency conducted in Canada, Great Britain, Finland, and India. This global pattern of death from magnesium deficiency is important in terms of setting priorities for further research and setting standards of nutrition. The needless drag on the U.S. economy from magnesium deficiency exceeds $86 billion per year.

HIGH-DOSE VITAMIN D DEPLETES MAGNESIUM

Vitamin D is the new sexy supplement on the block, so it's very much in the news. However, the association between vitamin D and magnesium is crucial and has been ignored in the current media frenzy. The important lesson is to make sure you are taking enough magnesium before supplementing with vitamin D. You can make sure you have enough magnesium by following your magnesium RBC levels and targeting an optimum of 6.0–6.5 mg/dL. Optimum vitamin D levels are actually more toward the low normal end of the range (around 40 ng/mL), not the high end. The range for OH–vitamin D is from 30.0 to 74.0 ng/mL.

You feel great on your magnesium supplements and then add high-dose vitamin D (anything from 5,000 IU to 50,000 IU), and you begin to feel worse and think you have magnesium deficiency all over again, or you assume your magnesium is no longer working. I've had emails from people who can't seem to take even 1,000 IU of vitamin D without negative reactions. Yet vitamin D is supposed to make you feel better. Even worse, you know nothing about magnesium and begin taking high doses of vitamin D and start having all sorts of unidentifiable symptoms.

Here's what happens. Magnesium is required for many steps along the pathway of vitamin D metabolism, including transformation of vitamin D from its storage form (which is also the supplement form) to its active form. That means if you take the extremely high doses that allopathic doctors are now recommending (50,000 IU), you can plummet into magnesium deficiency and not know

what's happening.

To make matters worse, calcium is a mineral that vitamin D grabs from the diet and holds on to for dear life. When you start taking high doses of vitamin D, you can accumulate so much calcium that it overrides your magnesium and forces it out of your body. In short, too much vitamin D can overutilize magnesium, block magnesium, purge magnesium, and propel people into magnesium deficiency. Read "The Fail-Safe of Magnesium" on this page to learn more about this calcium-magnesium dynamic.

An even more controversial aspect of vitamin D rests on the fact that it's actually a hormone. Hormone levels are regulated through a feedback system. For example, one of the main jobs of vitamin D is to grab calcium from the diet and put it in the bloodstream. When you have enough calcium, then vitamin D levels should go down because no more calcium is required and vitamin D is no longer necessary. But if you regard vitamin D as a vitamin, you might think it's not good for a vitamin to be low and you should take more of it.

In our current state of too much calcium and not enough magnesium in our diet and supplements, perhaps we are supplementing a hormone that the body doesn't need in such high doses.

I began investigating this aspect of vitamin D when people told me they were experiencing adverse reactions. These reactions include seizures, kidney stones, month-long migraines, and anxiety. People who were happy on their magnesium supplements would say all their magnesium

deficiency symptoms came back and didn't go away until they stopped vitamin D and added more magnesium.

Here are excerpts from letters sent to me about experiences people have had with taking high doses of vitamin D.

> I experienced high blood pressure and rapid heartbeat when taking even just 500 IU of vitamin D, I can't imagine what would happen if I took 50,000 IU!

> I started taking omega-3s and 5,000 IU of vitamin D in October 2010 and I did great! I could walk without a limp again, my knees stopped hurting, my feet stopped hurting. *But* I had a scary episode of angina in March 2012 and that's when I started taking more magnesium. I believe now I was taking too much vitamin D and it may have caused the angina.

> I've been using vitamin D supplements for around six months, and experienced heart palpitations during this period. I never connected the two until I heard Dr. Dean on *Coast to Coast* and did some research. I'm taking magnesium supplements now and the palpitation problem is much improved. Apparently the vitamin D was interfering with my magnesium levels.

> When I take a 1,000 IU vitamin D supplement daily, my elbows start to hurt, my knees start to hurt, my lower back starts to hurt and feel stiff, and I have angry thoughts. When I take magnesium, I feel relaxed and peaceful.
>
> I have been taking magnesium for a long time and every time I take vitamin D, I get a very bad reaction. I am taking 600 mg of magnesium citrate and 1,000 IU of vitamin D. I also spray on the magnesium oil.
>
> I know I developed angina because of high vitamin D. When I read your article I cut back and took more magnesium. You just don't know how frustrated I am now about how I was treated by the doctors while I was in the hospital. They were no help in solving my angina symptoms. All they could say is "This is stress related." And they prescribed an angina medication for me while leaving me scared for my life for the two weeks between my hospital stay and finding your website. I am such a believer in magnesium now, you just don't know, and I'm so thankful for you and your work. I just cannot thank you enough (with tears, really with tears).

In general, I don't recommend more than 1,000–2,000 IU of vitamin D daily. And never take any amount of vitamin D without magnesium. I do receive reports from people

who say they can take high amounts of vitamin D and have great benefit—but I wonder if these people are already well supplied with magnesium. As for the dosage of magnesium to take along with vitamin D, that is very individual; some people need more than others. I recommend doing the magnesium RBC test and taking ReMag, a source of magnesium that will enable you to take enough magnesium to help assimilate vitamin D without the laxative effect that can actually deplete your magnesium.

For the proper functioning of vitamin D, calcium, and magnesium, I recommend vitamin K_2. Dr. Price, the inspiration for the Weston A. Price Foundation and website, discovered the X factor, which turned out to be vitamin K_2. Vitamin K_2 helps guide calcium into the bones where it is needed instead of leaving it to calcify blood vessels and other soft tissues.

We are supposed to create our own vitamin K_2 in the gastrointestinal tract from vitamin K_1 found in leafy green vegetables, but most people are deficient. Vitamin K_2 is fat soluble, like vitamin A and vitamin D, and benefits from associating with good fats such as olive oil and coconut oil. Other sources of vitamin K_2 are animal products, including egg yolks and butter, from animals raised on green pasture. The only vegetarian source of vitamin K_2 is natto, a Japanese fermented soy product that some find difficult to tolerate due to its unique taste. In my practice, I recommend Blue Ice Royal (fermented cod liver oil plus butter oil) from Green Pastures as the perfect combination of all three fat-soluble vitamins.

Let me be clear. I don't know all the answers and you don't have to listen to me, but neither do you have to listen to anyone else. You have to listen to yourself and what makes sense to you and your body. Medicine is about taking big guns and shooting them off indiscriminately. For them, vitamin D is the new calcium; they will promote it very widely and wait a few decades for the negative fallout. I'm writing this so you can start asking questions. I don't want to wake up in ten or twenty years and find out we made a huge mistake in overdosing people with vitamin D, just as we did with calcium.

MAGNESIUM STUDIES

The studies supporting magnesium's role as a necessary mineral for health have exploded in the past few years. New reports on magnesium for memory, brain plasticity, life extension, chronic fatigue syndrome, diabetes, colon cancer, connective tissue, stroke, pancreatic enzyme function, neuroprotection in premature infants, prostate cancer, and glaucoma all caught my attention.

The latest reports on the association of cancer and magnesium are particularly exciting. Japan's National Cancer Center in Tokyo found that magnesium reduces a man's risk of colon cancer by over 50 percent. Higher intake of magnesium (at least 327 mg per day) was associated with a 52 percent lower risk of colon cancer, compared with men taking lower amounts.[25] This was quite a large study of 87,117 men, average age fifty-seven, followed for eight years. Dietary intake was assessed using a food frequency questionnaire. The average intake of magnesium for men in the study was documented at 284 milligrams per day.

I was honored to meet with a contingent from a Japanese magnesium company who came to visit me in 2013 to share their enthusiasm about the benefits of magnesium. This company, Tateho Chemical Industries, supplies magnesium that is used in industry. However, in the past few years, the president of the company, Mr. Tetsunori Minato, has become very interested in the use of magnesium supplements in health. To that end, Tateho Chemical Industries has funded several internationally recognized magnesium researchers at prestigious

universities in Japan to further the acceptance of magnesium as a key nutrient in preventing disease. The focus of research has ranged from diabetes and heart disease to cancer.

The research of Dr. Kuninobu Yokota and his collaborators has shown many benefits of magnesium, including improved insulin resistance, decreased triglycerides, reduced blood pressure, and lowered lipid levels.[26],[27] Dr. Ka He's group in the United States, including Dr. Yokota, reported that higher magnesium intake reduces the risk of diabetes by about 50 percent in young American adults.[28]

Another colleague, Dr. Takuji Tanaka, is investigating the role of magnesium in cancer prevention. Meta-analyses have shown that higher intake of dietary magnesium is associated with lower risk of colorectal tumors. Dr. Tanaka's research uncovered the mechanism. Magnesium inhibits inflammation-related mouse colon cancer by modulating the proliferative activities and chromosomal instability of colorectal cancer.[29] The recommendation is to fund clinical trials of magnesium in people with colon inflammation who are at risk for colorectal cancer and show that magnesium prevents cancer from forming.

There is a free online book edited by Robert Vink and Mihai Nechifor called *Magnesium in the Central Nervous System* (2011). You can print out chapters to give to doctors as you try to convince them to give your loved ones magnesium while they are dying in the hospital from magnesium deficiency. The following chapter titles from this book show the expanding scope of magnesium

research. Each chapter is a paper written by a magnesium researcher or expert covering important topics involving the central nervous system.

MAGNESIUM IN THE CENTRAL NERVOUS SYSTEM

1. Free Magnesium Concentration in Human Brain
2. Intracellular Magnesium Homeostasis
3. Magnesium Transport Across the Blood-Brain Barriers
4. Intracellular Free Mg^{2+} and $MgATP^{2-}$ in Coordinate Control of Protein Synthesis and Cell Proliferation
5. Magnesium and the Ying-Yang Interplay in Apoptosis
6. Brain Magnesium Homeostasis as a Target for Reducing Cognitive Ageing
7. The Role of Magnesium Therapy in Learning and Memory
8. The Role of Magnesium in Headache and Migraine
9. Magnesium in Edema and Blood-Brain Barrier Disruption
10. Magnesium and Hearing Loss

11. The Role of Magnesium in Pain
12. The Role of Magnesium in Traumatic CNS Injury
13. The Use of Magnesium in Experimental Cerebral Ischaemia
14. Magnesium in Subarachnoid Hemorrhage
15. Magnesium in Clinical Stroke
16. Magnesium in Cancer: More Questions than Answers
17. Magnesium in Parkinson's Disease: An Update in Clinical and Basic Aspects
18. Magnesium and Alzheimer's Disease
19. Magnesium and Stress
20. Magnesium in Neuroses
21. Magnesium, Hyperactivity and Autism in Children
22. Magnesium in psychoses (schizophrenia, bipolar disorder)
23. Magnesium and Major Depression
24. Magnesium in Drug Abuse and Addiction

I could list dozens of recent studies proving or confirming the effectiveness of magnesium therapy in asthma, ADHD, anxiety and depression, cancer, genetic disease, heart disease, osteoporosis, and more, but instead I'll direct you to the website of the nonprofit Nutritional Magnesium Association (NMA), www.nutritionalmagnesium.org. I'm on the Medical Advisory Board of the NMA. On that

website you will find all the references you or your doctor desires to prove the safety and efficacy of magnesium therapy.

PART ONE

THE HISTORY OF MAGNESIUM

CHAPTER ONE

THE CASE FOR MAGNESIUM

Mary joked that she felt as though she were constantly being run over by a slow-moving bus. Cramping in her legs startled her awake at night, making her an insomniac, and she had heart palpitations daily. Her doctor also found that she had high blood sugar. It wasn't bad enough for her to need injections of insulin, but he prescribed pills to try to stimulate more insulin production. Finally, frightening panic attacks came out of nowhere and made this vibrant, fun-loving woman afraid to go outside.

To try to relieve her leg cramps, Mary began taking calcium at night, having read that it was good for cramps and sleep. At first, the calcium seemed to help, but after a week or two, the pains got worse. If she yawned and stretched in bed, her calf muscles would seize up and catapult her to the floor, where she would lie frantically massaging her muscles to try to release the spasm. All the next day, she would limp about with a very tender, bruised feeling in her calf.

Although Mary's heart palpitations had improved somewhat after she'd given up her three cups of coffee a day, they too resumed after a few weeks. Every time the palpitations occurred, which was several times a day, they made her cough slightly and catch her breath. She found it

frightening, even though her doctor said her stress tests for heart disease were fine and she didn't need further testing with an angiogram.

Both Mary's parents had had adult-onset diabetes, and Mary knew that she should watch her diet, but she was overweight and craved sugary and high-carbohydrate foods that were hard to resist. When the panic attacks hit on top of everything else, Mary knew she had to seek help, and came to my office. She was only fifty-three, far too young to be feeling so bad, and was worried about her future health.

Sam was only forty-nine and experiencing chest pains. At first, he thought they were indigestion, but sometimes the pains would occur in the middle of the night. Concerned, he went to a cardiologist, who found two slightly blocked arteries, not serious enough for bypass surgery. Sam's cholesterol was somewhat elevated, as was his blood pressure, which he attributed to his high-stress occupation and the fact that he had not exercised regularly for the past six months, when he was sidelined with back pain. The cardiologist observed that his arterial blockage would almost inevitably worsen over time and eventually necessitate surgery. The doctor offered him medication for his high cholesterol, told him not to eat butter or eggs, and gave him nitroglycerine to take whenever he had the pain. If the symptoms got worse, he would prescribe other medications. Sam couldn't imagine having to wait to get worse before doing something about his chest pain; he knew there must be something more he could do to avoid surgery, and came to me for advice.

At thirty-five, Jan had actually begun to look forward to going through menopause. That's how bad her PMS symptoms were. As soon as those horrible feelings lifted, she was hit by the sledgehammer of menstrual cramps. She also had migraines, which for years had come before her period but now were occurring once or twice a week. She was so miserable that she was considering a complete hysterectomy, with removal of her hormone-producing ovaries, but wondered whether the migraines, since they were happening all month, were not actually hormonal.

Different as their symptoms are, Mary, Sam, and Jan all suffer from magnesium deficiency. While women and men seem equally susceptible to magnesium deficiency, women, pound for pound, have less magnesium. They have fewer circulating red blood cells, which carry magnesium, and so perhaps less magnesium available, but they seem to utilize the magnesium they do have more efficiently than men.

There are a few other gender differences. Because of magnesium's effect on hormonal regulation and vice versa, women appear to have more problems with low magnesium because they can suffer deficiencies during pregnancy, when breastfeeding, with premenstrual syndrome (PMS), and with dysmenorrhea (painful periods). Osteoporosis, which affects more women than men, is evidence of an imbalance of calcium and magnesium. An overactive thyroid, which afflicts more women than men, increases the metabolic rate, which uses up magnesium-requiring ATP (adenosine triphosphate—the energy packets made in each cell in the body). Without magnesium, ATP would not be produced. However,

women's efficient use of magnesium may explain why prior to menopause they are protected from heart attacks.

Let's follow Mary, Sam, and Jan and see how they overcame their magnesium deficiencies.

When Mary visited me, I charted her health history in detail, according to procedures commonly used by naturopathic doctors, and found several symptoms of magnesium deficiency. In her case it had been made even worse by too much calcium, however, so simple magnesium supplementation wouldn't be enough for Mary. Her diet and lifestyle needed a complete overhaul. I explained that calcium appears to help leg cramps, at least initially, because excess calcium forces magnesium to be released from storage sites. But if someone is magnesium-deficient, the excess calcium can begin to cause more problems.

I gave Mary a list of magnesium-rich foods that she needed to start eating, which included nuts, beans, greens, and seeds such as sunflower and pumpkin. Mary realized that she'd been avoiding almost all of these foods: she thought nuts were fattening, beans gave her gas, and greens never seemed fresh enough at the supermarket. She had never even thought about eating seeds.

After a week of enthusiastically eating a lot more magnesium-rich foods, Mary felt somewhat better. To make sure she could get fresh organic greens regularly, she tracked down a local community-supported agriculture (CSA) program and bought a share in a neighboring organic farm. Mary also learned how to soak and cook beans to prevent them from causing gas, and began eating

nuts and seeds rich in magnesium and healthy oils, such as almonds, walnuts, pecans, sunflower seeds, and pumpkin seeds.

After her second visit I recommended that Mary begin taking magnesium supplements. Starting with a dosage of 200 mg a day, we added another 200 mg every two days to build slowly to 600 mg. I cautioned her that it could take months to eliminate magnesium deficiency symptoms and that not all her symptoms would necessarily respond quickly. Mary, excited by the improvement she felt by just increasing magnesium-rich foods, expressed impatience and wanted to know if she should have intravenous magnesium to saturate her tissues more quickly. I explained that IV magnesium would indeed do just that, but a more effective and much less expensive way would be to add picometer magnesium and use Epsom salts regularly in baths, including foot baths. Within one month, Mary was singing the praises of magnesium. Her palpitations and panic attacks had disappeared. Her cravings for sweets were fewer, she was able to control her blood sugar with diet alone, and tests for blood sugar were normal. Her leg cramps were gone, and with them her insomnia. At three months we added calcium-rich foods along with magnesium supplements to keep a 1:1 ratio between the two. Mary's internist was quite surprised at her improved health and told her to keep up the good work with her diet and supplements.

Sam had an inquiring mind, and I encouraged him to start reading about heart disease and magnesium. He found that up to 30 percent of angina (chest pain) patients do not

have badly blocked arteries but may be suffering from an electrical imbalance that is driven by mineral deficiency, most commonly magnesium.[1] An astonishing 40 to 60 percent of sudden deaths from heart attack may occur in the complete absence of any prior artery blockage, clot formation, or heart rhythm abnormalities, most likely from spasms in the arteries (magnesium is a natural antispasmodic).[2], [3], [4], [5] Moreover, he found that magnesium deficiency has been linked to sudden cardiac death. Sam didn't want to wait around for that to happen to him; he was determined to find out what was causing his problem and treat the cause. The more he read, the more intrigued he became. When he read that magnesium deficiency is also associated with muscle pain, especially back pain, that really got his attention, since he had begun having back pain four or five months before he developed chest pain.[6]

With a packet of information on magnesium, Sam went back to his cardiologist. After waiting impatiently for the doctor a full thirty minutes, a nurse took Sam's blood pressure; it was elevated, even though at home it was usually only a few points above normal. (Doctor-induced hypertension is commonly reported by patients.) After hearing the blood pressure reading from his nurse, the cardiologist swept into Sam's room and immediately began talking about blood pressure medication. Sam countered with magnesium. The cardiologist visibly cooled and said that magnesium was used to control hypertension that occurred in pregnant women because there were no side effects, but that there were plenty of effective drugs for

everyone else. When Sam said he would rather not have side effects either, the cardiologist gathered up his file and told him to come back when he was ready to take medications for his heart disease.

When Sam came back to see me, he was still pretty upset by this encounter; he didn't like the specialist refusing to discuss a possible magnesium deficiency as part of the picture. Sam and I agreed that magnesium seemed the best treatment for him to initiate at this time since he was not willing to take medications.

Sam began adding magnesium to his diet by eating magnesium-rich foods. After a week he felt much calmer, but he still had chest and back pain. So he added magnesium supplements, and in about three months he felt almost normal.

Among the studies Sam read was one that looked at the correspondence between type A personalities and magnesium deficiency. From the description, Sam realized he was a type A, an aggressive guy who lived on adrenaline, time pressure, and stress. This type of behavior drains the body of magnesium and can lead to disorders such as heart disease, muscle spasms, hypersensitivity, and irritability.[7] Prolonged psychological stress raises adrenaline, the stress hormone, which depletes magnesium.[8] Both Sam's back and chest pain would hit when he was under stress. So Sam worked on ways to control his stress and added more magnesium when he knew he couldn't avoid it. On days when he exercised, Sam added an extra 200 mg of magnesium to his regime, since sweat loss during heavy exercise (cycling and jogging) and

working in the heat deplete magnesium. Just drinking water won't replace all the minerals lost. By paying attention to the many factors that affected his mind-body health, Sam lowered his cholesterol and stress levels and reduced his chance of a heart attack and of needing surgery to unblock his arteries.

Jan heard that yoga might help her PMS and painful periods, and she really needed to learn to relax, so she took classes at a local health club. The teacher also ran regular detox and cooking classes, which Jan decided to join when she realized she didn't have to "give up everything" and become a vegetarian. One of the first things Jan learned in the detox class was the importance of having regular bowel movements. Jan was lucky if she had one a week. If the bowel doesn't empty once a day, toxins can be reabsorbed back into the body from the colon. The longer debris sits in the colon, the more fluid is reabsorbed, making stools more solid and difficult to pass. PMS and endometriosis, which causes painful periods, are considered by some natural-health experts to worsen with constipation and toxicity.[9]

During cooking classes, Jan faced the fact that she was a junk food addict. Magnesium is necessary in hundreds of enzymes in the body but is almost totally lost during the processing of packaged and fast foods. The older women in her class were suffering from a variety of problems that included cancer, heart disease, and osteoporosis. Is that how she would end up in ten or twenty years if she didn't take care of her health now? Learning how many basic nutrients she lacked in her diet made her marvel that she wasn't even more ill. Her new diet included greens, beans,

nuts, and seeds, which cleared up her constipation and almost eliminated her PMS and painful periods. When she came to see me on the advice of her yoga teacher, it was clear she was on the right track. I recommended that she begin taking a magnesium supplement, a food-based multivitamin/mineral, and increase her dietary calcium. With all her lifestyle changes, she felt like a new person.

MAGNESIUM, THE SPARK OF LIFE

In a poetic reference to magnesium's crucial role in evolution, Dr. Jerry Aikawa of the University of Colorado calls magnesium the ur-mineral, the most important mineral to man and all other living organisms.[10] It is critical to the metabolic processes of lowly one-celled living organisms and is the second most abundant element inside human cells. Magnesium existed at the beginning of life and was involved with all aspects of cell production and growth. When plants evolved to use the sun as their energy source, magnesium played a pivotal role in the development of chlorophyll. So in both plants and animals, magnesium became an essential mineral involved in hundreds of enzyme processes affecting every aspect of life.

Presently, seventeen minerals are considered essential for human life, and it is quite possible that more minerals will be found to be indispensable as we take more time to study life's mineral connection. Ninety-nine percent of the body's mineral content is made up of seven macrominerals: sodium, potassium, calcium, phosphorus, chlorine, sulfur, and magnesium. The other 1 percent comprises ten trace minerals. As with most minerals, the element magnesium occurs in nature combined with other elements. It joins naturally with sulfur to make Epsom salts (magnesium sulfate), with carbon to make magnesium carbonate, and with calcium to make dolomite. Magnesium is also found in partnership with silica in talc and asbestos. Like calcium, it is an alkaline mineral, which neutralizes acid, and some magnesium compounds are antacids used to treat heartburn.

My first encounter with magnesium was in high school chemistry. Each student was given a thin strip of magnesium and told to light one end carefully. The previous week we had learned that magnesium is the eighth most abundant element, constituting approximately 2 percent of the earth's crust and 0.13 percent (1272 ppm) of seawater. By comparison, calcium makes up 3 percent of the earth's crust but only 0.04 percent (440 ppm) of seawater. There are 4–6 tsp (20–28 g or 2 oz) of magnesium in the body, comprising about 0.05 percent of the body's weight. This information in no way prepared us for the dynamic effect of lighting the magnesium strip. It flared up like an electric sparkler and disappeared in a flash. This incendiary property serves as an important reminder of magnesium's versatility as the spark of life, constantly igniting metabolic reactions throughout the body.

THE BODY IS ELECTRIC

The impulses for any and all movement in the body arise from electrical transmission. These microcurrents of electricity that pass along the nerves were first measured in 1966. Scientists soon discovered that the conductor for these bodily electrical currents was calcium and that magnesium was necessary to maintain the proper level of calcium in the blood.[11] More recent research indicates that calcium enters the cells by way of calcium channels that are jealously guarded by magnesium. Magnesium, at a concentration 10,000 times greater than that of calcium in the cells, allows only a certain amount of calcium to enter to create the necessary electrical transmission, and then immediately helps to eject the calcium once the work is done. Why? If calcium accumulates in the cell, it causes hyperexcitibility and calcification and disrupts cell function. Too much calcium entering cells can cause symptoms of heart disease (such as angina, high blood pressure, and arrhythmia), asthma, or headaches. Magnesium is nature's calcium channel blocker.[12], [13], [14]

About 60–65 percent of all our magnesium is housed in our bones and teeth. The remaining 35–40 percent is found in the rest of the body, including muscle and tissue cells and body fluids. The highest concentrations are in the heart and brain cells, so it is no wonder that the major symptoms of magnesium deficiency affect the heart and brain. These are also the two organs that have considerable electrical activity, measured by EKG (electrocardiogram) and EEG (electroencephalogram). Our blood contains only *1 percent* of the body's total magnesium.

Magnesium mostly works inside our tissue cells, bonding with ATP to produce energy packets for our body's vital force. Not enough can be said about the importance of this energy-producing function of magnesium. The combination of ATP and magnesium triggers production of all the body's protein structures by revving up messenger RNA. This combination is also a requirement for the production of DNA, our genetic code. Both basic building blocks of life, RNA and DNA, are dependent on ATP/magnesium to maintain stable genes.[15] In addition to its stabilizing effect on DNA and the structure of chromosomes, ATP/magnesium is an essential cofactor in almost all enzyme systems involved in the processing of DNA. Research shows that without sufficient magnesium, DNA synthesis becomes sluggish.

WHAT DOES MAGNESIUM DO?

Magnesium's hundreds of activities in the human body can be divided into five essential categories:[16]

1. Magnesium is a cofactor assisting enzymes in catalyzing most chemical reactions in the body, including temperature regulation.
2. Magnesium produces and transports energy.
3. Magnesium is necessary for the synthesis of protein.
4. Magnesium helps to transmit nerve signals.
5. Magnesium helps to relax muscles.

1. COFACTOR IN CHEMICAL REACTIONS

Enzymes are protein molecules that stimulate every chemical reaction in the body. Magnesium is required to make hundreds of these enzymes work and assists with thousands of others.

2. PRODUCING AND TRANSPORTING ENERGY

Magnesium and the B-complex vitamins are excellent examples of energy nutrients, because they activate enzymes that control digestion, absorption, and the utilization of proteins, fats, and carbohydrates. Because magnesium is involved with hundreds of enzymatic reactions throughout the body, deficiency can affect every aspect of life and cause a score of symptoms. Of the 700–800 magnesium-dependent enzymes, the most important enzyme reaction involves the creation of energy by activating adenosine triphosphate (ATP), the fundamental energy storage molecule of the body. ATP may be what the Chinese refer to as *qi* or life force. Magnesium is required for the body to produce and store energy. Without magnesium there is no energy, no movement, no life. It is that simple.

3. SYNTHESIZING PROTEIN

Magnesium is used in synergy with dozens of other vitamins and minerals to create structural components of the body. Under the direction of magnesium, enzymes and nutrients modify the building blocks from food to create the body. Without magnesium, there is no body. RNA and DNA, which contain the genetic blueprints for the formation of all the protein molecules in the body, are also dependent on magnesium.

4. TRANSMITTING NERVE SIGNALS

Magnesium permits a small amount of calcium to enter a nerve cell, just enough to allow electrical transmission along the nerves to and from the brain, then forces it back outside. Even our thoughts, via brain neurons, are dependent on magnesium.

5. RELAXING MUSCLES

Calcium causes contraction in skeletal muscle fibers, and magnesium causes relaxation. When there is too much calcium and insufficient magnesium inside a cell, you can get sustained muscle contraction: twitches, spasms, and even convulsions. Smooth muscles directed by too much calcium and insufficient magnesium can tighten the bronchial tract, causing asthma; cause cramping in the uterus and painful periods; and cause spasms in blood vessels, resulting in hypertension.

WHO IS DEFICIENT?

The most frequent questions I'm asked about magnesium is "How do I know I need more magnesium?" and "Should I take magnesium supplements?" I have come to the conclusion that everyone could benefit from extra supplementation. However, there is a long list of possible symptoms and behaviors that can identify your need for magnesium. The following 100 factors in 68 categories can help you recognize magnesium deficiency. There's no way of knowing how many factors correlate with any one person's magnesium deficiency, but if you find yourself ticking off a few dozen, you may want see how many of your symptoms improve when you take magnesium supplements.

1. Alcohol intake—more than seven drinks per week
2. Anger
3. Angina
4. Anxiety
5. Apathy
6. Arrhythmia of the heart 7. Asthma
8. Blood tests

a. Low calcium b. Low potassium c. Low magnesium

9. Bowel problems

a. Undigested fat in stool b. Constipation c. Diarrhea

d. Alternating constipation and diarrhea e. IBS

f. Crohn's

g. Colitis

Brain trauma

Bronchitis, chronic

Caffeine (coffee, tea, chocolate), more than three servings per day 13. Chronic fatigue syndrome

Cold extremities

Concentration difficulties

Confusion

Convulsions

Depression

Diabetes

a. Type I

b. Type II

c. Gestational diabetes

Fibromyalgia

Food intake imbalances

a. Limited in green leafy vegetables, seeds, and fresh fruit b. High protein

Food cravings

a. Carbohydrates b. Chocolate

c. Salt

d. Junk food

Gagging or choking on food

Headaches

Heart disease

Heart—rapid rate

High blood pressure

Homocysteinuria

Hyperactivity

Hyperventilation

Infertility

Insomnia

Irritability

Kidney stones

Medications

a. Digitalis

b. Diuretics

c. Antibiotics d. Steroids

e. Oral contraceptives f. Indomethacin g. Cisplatin

h. Amphotericin B

i. Cholestyramine j. Synthetic estrogens

Memory impairment

Mercury amalgam dental fillings

Menstrual pain and cramps 39. Migraines

Mineral supplements

a. Take calcium without magnesium b. Take zinc without magnesium c. Take iron without magnesium

Mitral valve prolapse

Muscle cramps or spasms

Muscle twitching or tics

Muscle weakness

Numbness of hands or feet

Osteoporosis

Paranoia

Parathyroid hyperactivity

PMS

Polycystic ovarian disease

Pregnancy

a. Currently pregnant b. Pregnant within one year c. History of preeclampsia or eclampsia d. Postpartum depression e. Have a child with cerebral palsy

Radiation therapy, recent

Raynaud's syndrome

Restlessness

Sexual energy diminished

Shortness of breath

Smoking

Startled easily by noise

Stressful life or circumstances

Stroke

Sugar, high intake daily

Syndrome X

Thyroid hyperactivity

Tingling of hands or feet 65. Transplants

a. Kidney
b. Liver

Tremor of the hands

Water that contains the following

a. Fluoride
b. Chlorine
c. Calcium

Wheezing

THE DANCE OF CALCIUM AND MAGNESIUM

Calcium and magnesium share equal importance in our bodies. Appropriating Newton's law of physics that says for every action there is an equal and opposite reaction, neither calcium or magnesium can act without eliciting a reaction from the other. At the biochemical level, magnesium and calcium are known to act antagonistically toward each other. Many enzymes whose activities critically depend on a sufficient amount of intracellular magnesium (10,000 times more than calcium) will be detrimentally affected by small increases in levels of cellular calcium. Growth of cells, cell division, and intermediary metabolism are also absolutely dependent on the availability of magnesium, which can be compromised if excess calcium is present.[17]

To understand how you can create a calcium/magnesium imbalance in your own body, try this experiment in your kitchen. Crush a calcium pill and see how much dissolves in 1 oz of water. Then crush a magnesium pill and slowly stir it into the calcium water. When you introduce the magnesium, the remaining calcium dissolves; it becomes more water-soluble. The same thing happens in your bloodstream, heart, brain, kidneys, and all the other tissues in your body. If you don't have enough magnesium to help keep calcium dissolved, you can develop muscle spasms, fibromyalgia, hardening of the arteries, dental cavities, and calcium deposits (including breast tissue calcification). Another scenario plays out in the kidneys and bladder. If there is too much calcium in the kidneys and not enough magnesium to dissolve it, you can get kidney stones.

Calcium deposited throughout the bladder can make it rigid, lower its capacity, and lead to frequent urination.

All muscles, including the heart and blood vessels, contain more magnesium than calcium. If magnesium is deficient, calcium floods the smooth muscle cells of the blood vessels and causes spasms leading to constricted blood vessels and therefore higher blood pressure, arterial spasm, angina, and heart attack.[18] A proper balance of magnesium in relation to calcium can prevent these symptoms. Calcium excess, stimulating the cells in the muscular layer of the temporal arteries (located over the temples) can cause migraine headaches. Excess calcium can constrict the smooth muscle surrounding the small airways of the lung, causing restricted breathing and asthma. Finally, too much calcium, without the protective effect of magnesium, can irritate delicate nerve cells of the brain. Cells that are irritated by calcium fire electrical impulses repeatedly, depleting their energy stores and causing cell death.

THE CALCIUM DISTRACTION

The irony of the calcium-magnesium story is that without magnesium calcium will not work properly. Both our current diet and tendency to oversupplement with calcium, however, make getting enough magnesium almost impossible. Research shows that the ratio of calcium to magnesium in the Paleolithic or caveman diet—the ancient diet that evolved with our bodies—was 1:1, compared with a 5:1 to 15:1 ratio in present-day diets.[19] With an average of ten times more calcium than magnesium in our current diet, there is no doubt about widespread magnesium deficiency in modern times.

The emphasis on calcium supplementation has diverted our attention from any other mineral, even though all minerals are crucial to the proper functioning of the body. In our society we tend to look for "the best," "the most important," "the star," and forget that it takes a team and teamwork to get anything accomplished, including body processes. Calcium, because it is the most abundant mineral in the body, therefore became "the star." Even though research has accumulated on magnesium over the past four decades, it has never been adequately publicized and discussed. In the Introduction, if you haven't already, be sure to read the section "The Failure of Calcium."

CHAPTER TWO

MAGNESIUM: THE MISSING MINERAL

A 1988 U.S. government study concluded that the standard American diet failed to provide the daily requirement of magnesium.[1] That was almost two decades ago, and you can be sure that most people get even less today, when junk food makes up 27 percent of our diet. Mildred Seelig, M.D., and many other magnesium experts have also come to the inescapable conclusion that the typical American diet, which is rich in fat, sugar, salt, synthetic vitamin D, phosphates, protein, and supplemented calcium, not only is deficient in magnesium but actually *increases* the need for magnesium in the body.

Unfortunately, it is impossible to find studies that tell us the actual incidence of magnesium deficiency. This stems from there being no accepted medical standard for measuring whole-body magnesium status. As will be discussed in Chapter 16, blood testing for magnesium relies on inadequate measurements since only 1 percent of the body's magnesium is in the blood and only 40 percent in the tissues. The National Academy of Sciences found that *most* Americans are possibly magnesium-deficient. When men obtain only 80 percent of the minimum requirement of magnesium to run innumerable body functions and women at 70 percent get even less of what they absolutely

need, then our bodies are just not able to function properly.[2]

Let's look at some of the reasons you may be lacking in magnesium—and it begins with what's missing from the soil.

MAGNESIUM-DEFICIENT SOIL

The mineral depletion of our farmland quoted from the 1936 Senate document in the introduction to *The Magnesium Miracle* is probably the most important reason why most Americans are magnesium-deficient. Unfortunately, the issue of depleted soils has not been addressed in America. As Kirkpatrick Sale expressed in *The Nation*, after World War II it only got worse.

> When U.S. industrialism turned to agriculture after World War II, for example, it went at it with all that it had just learned on the battlefield, using tractors modeled on wartime tanks to cut up vast fields, crop-dusters modeled on wartime planes to spray poisons, and pesticides and herbicides developed from wartime chemical weapons and defoliants to destroy unwanted species. It was a war on the land, sweeping and sophisticated as modern mechanization can be, capable of depleting topsoil at the rate of 3 billion tons a year and water at the rate of 10 billion gallons a year. It could be no other way: If a nation like this beats its swords into plowshares, they will still be violent and deadly tools.
>
> —*The Nation*, June 5, 1995

DEAD SOIL

Kirkpatrick Sale talks about the war waged on the land and all species on it by farmers lured into believing that killing weeds and pests was far superior to living in harmony with nature. The whole experiment backfired when it became clear that the poisons could not be controlled—they killed indiscriminately. Without living worms and nitrogen-fixing rhizobacteria, the soil became dead. Worms break up the earth, leaving their own form of compost behind, and without this activity the soil becomes hard and nonporous. Bacteria in the soil make it possible for plants to absorb certain nutrients, and without their action plants are weaker and less nutritious.

Observing animals can teach us important lessons about our environment—if we only listen. One man who did was André Voisin, a French biochemist and farmer born in 1903. In 1963 Voisin wrote a book called *Grass Tetany*. Grass tetany is a metabolic disease of cattle and goats caused by a deficiency of magnesium in the soil. When animals eat magnesium-deficient grass they develop irritability, staggering, tremors, and spasms. Most dramatically, the animals fall down in convulsions at sudden loud noises or if they are frightened or excited. Voisin reported that in the 1930s magnesium deficiency had been proven to be the cause of grass tetany, since low levels of magnesium were found in suffering animals and the condition was miraculously reversed by injections of magnesium.

Chapter 1 of Voisin's book says it all: "Modern Farming Methods Favour the Development of Grass Tetany." In his

career as a farmer, Voisin observed that “intensive grazing” and the overuse of mineral-deficient commercial fertilizers were common practices. At the time, Voisin identified Holland as the country that used the most commercial fertilizer on its pastures and also suffered the most grass tetany.

A potassium product called potash has been the fertilizer of choice since the 1930s. It’s cheap, easily obtained, and readily absorbed by plants. In fact, it is so easily taken up by plants that when there is an abundance of potassium they favor its absorption above magnesium and calcium, which are relatively harder to absorb. Crops grown with excessive amounts of potash have a low content of magnesium and calcium and high potassium levels. However, you would never know that since there is no minimum amount of minerals required in our grains, fruits, or vegetables—the nutrients in such foods are not routinely measured and never labeled.

Even if the magnesium content of soil is high, using potassium fertilizer can prevent its absorption into the plant. But because most agricultural land in America has been overworked for decades and fertilizers don’t replace this important mineral, magnesium is rarely found in our soils.

SOIL EROSION

Paul Mason, owner of a magnesium-rich spring in California, reminds us that magnesium is also susceptible to being leached from cultivated soil.[3] Based on a measure of the dissolved magnesium in the Mississippi River, estimates are that the annual loss of magnesium from midwestern soils is an incredible 7.1 million kg at least, and likely more if the magnesium in undissolved dirt carried by the river is included.

BURNING OFF MAGNESIUM WITH ACID RAIN

Acid rain provides yet another attack on the magnesium in soil; it occurs in industrial and urban areas that experience excessive air pollution. Atmospheric scientist William Grant, during his study of air pollution, concluded that an accumulation of acid rain, which contains nitric acid, can change the chemistry of the soil in which trees grow.[4] This abnormal soil acidity creates a reaction with calcium and magnesium in the soil to neutralize the excess nitric acid. He found that eventually these minerals are depleted, leaving the nitric acid to react with the aluminum oxide in the soil. The reactive aluminum builds up, replaces the calcium and magnesium in the plant, and makes it difficult for the plant to survive.

Calcium is beneficial to trees and plants because it strengthens the walls of the cells that combine to shape the tree, so without it plants weaken. Magnesium is an essential component of the chlorophyll necessary for photosynthesis, during which organic chemicals are produced during exposure to sunlight. While calcium and magnesium deficiencies weaken plants, acid rain also provides more nitrates to the plants, causing them to grow faster. The lack of calcium and magnesium, however, means that this early growth cannot be supported, and the plants may be too weak to survive.

If we eat plants that are grown on soil contaminated with acid rain, they may be very deficient in calcium and magnesium. On the farm, soil acidity is tested, and if the soil is too acid it is usually treated with lime—a calcium oxide product. Treating with lime is another practice that

can result in magnesium-deficient plants. You can read more about calcium-magnesium interactions on this page.

DEFICIENT PRODUCE FROM DEFICIENT SOIL

When you walk into a grocery story and pick up your produce, for the most part you just want it to look nice. You reject bruised, wilted, or misshapen vegetables or fruit. This emphasis on superficial appearance, not nutritional content, is what drives the industry. There is no labeling law that requires that the level of magnesium be displayed prominently.

Foods that commonly contain magnesium are leafy green vegetables, nuts, seeds, and whole grains. However, unlike vitamins, which can be manufactured by plants if they have sufficient sunlight and water, minerals must be present in the soil to show up in plants. If there is no magnesium in the soil, plants will have none; they cannot manufacture it out of thin air. So don't believe it when someone says that you can get all your nutrients in a good, balanced diet. That may be true only if you eat organic food, and then only if the organic farmers use a full spectrum of nutrients in their fertilizer. I'm convinced that to get enough magnesium today, you need to take supplements.

PROCESSED FOOD LACKS MAGNESIUM

During the refining and processing of food, significant amounts of magnesium can be lost. The process of extracting oils from magnesium-rich nuts and seeds strips away this essential mineral. Nearly all the magnesium in grains is lost during the milling process when the bran and germ are removed from whole grain to make white flour. For example, one slice of whole-wheat bread holds on to 24 mg of the mineral, while a slice of white bread has only 6 mg. And yet magnesium is never considered in the fortification of refined foods. Finally, in the kitchen, when vegetables are boiled, magnesium leaches out into the water. Of note is the fact that less calcium than magnesium is lost due to food processing and cooking, making the average diet higher in calcium than magnesium.

PERCENTAGE OF MAGNESIUM LOST DURING FOOD PROCESSING

Refining of flour from wheat	80 percent
Polishing of rice	83 percent
Production of starch from corn	97 percent
Extraction of white sugar from molasses	99 percent

What can we do to defend our magnesium sources? It is best to buy organic foods, eat as many raw vegetables as possible, and when you do cook vegetables, quickly steam them for only a few minutes, until they are slightly cooked but still crisp. You must also save the nutrient-filled water to use as soup stock. Chapter 17 presents the Magnesium Eating Plan, through which you can add whole grains, nuts, seeds, and greens to your diet.

FLUORIDATED WATER BANISHES MAGNESIUM

Fluoridation of tap water is a disaster that threatens to afflict the population with an epidemic of arthritis and, by recent reports, cancer as well. While most of Europe and half of the United States have completely abandoned the use of fluoride in the water supply, it still remains in the other half of the United States, in toothpaste, and as a molecule in SSRI antidepressants such as Prozac. Fluoride seeks out minerals such as magnesium and binds with it, making magnesium unavailable to the body and unable to do its work. The magnesium fluoride mineral produced is called sellaite; it is almost insoluble and ends up taking the place of magnesium in hard tissues like bone and cartilage, but its brittleness makes the bone susceptible to fracture. The reduction in available magnesium causes a decrease in enzymatic action in the body.[5]

In addition to its interactions with magnesium, fluoride has other harmful effects in the body. When I interviewed Dr. Paul Connett from the Fluoride Action Network on a radio program in September 2005, he reported that Harvard grad student Elise Bassin, in her Ph.D. thesis, found a strong correlation between water fluoridation and osteosarcoma, a type of bone cancer. There was a 700 percent increase in osteosarcoma in young men if they were exposed to fluoridated water during their sixth to eighth years. And according to the U.S. Department of Health and Human Services, “subsets of the population may be unusually susceptible to the toxic effects of fluoride and its compounds. These populations include the elderly, people with magnesium deficiency, and people with

cardiovascular and kidney problems."[6]

STOMACH ACID IS ESSENTIAL FOR MAGNESIUM ABSORPTION

Inefficient stomach digestion and faulty intestinal absorption can lead to magnesium deficiency. What's worse, when magnesium is deficient, gastric acid production is diminished, hindering magnesium absorption even more.

When you are under serious physical or even emotional stress, your body might not produce sufficient stomach acid, which is required for digestion and for chemically changing minerals into an absorbable form. Minerals are usually bound to another substance to make a mineral complex; for example, magnesium bound to citric acid creates magnesium citrate, and bound to the amino acid taurine it makes magnesium taurate. When a magnesium complex hits the stomach, it needs an acidic environment to help break the two substances apart, leaving magnesium in the ionic form and ready for action in the body.

The elderly as well as people with arthritis, asthma, depression, diabetes, gallbladder disease, osteoporosis, or gum disease are often deficient in hydrochloric acid.[7] All these conditions are also associated with magnesium deficiency.

Another disruption to digestion is America's addiction to antacids—the number one over-the-counter drug family. Heartburn and indigestion, the result of bad eating habits, plague the nation. But the "cure" in this case is no better than the disease. The roiling and burning in the gut from sugary junk food and greasy fast food is being inappropriately blamed on *too much* stomach acid. In

many cases, heartburn is due to sugar fermentation in the stomach and a backflow of pancreatic enzymes from the small intestine.[8] By neutralizing normal stomach acids, antacids make it impossible for us to absorb minerals or digest our food properly. Our magnesium can be even further depleted if we use calcium carbonate antacids because the calcium they contain causes more magnesium to be excreted.

It's also important to understand the grave effects low stomach acid and low magnesium have on calcium absorption. I've already talked about calcium's inability to dissolve in water, making it entirely dependent on stomach acid to put it into solution. However, when it leaves the stomach's highly acidic environment it enters the alkaline environment of the small intestine and precipitates out of solution unless sufficient magnesium is present. Without magnesium to keep it in solution, calcium quickly deposits in soft tissues throughout the body.

In the large intestine, it interferes with peristalsis (the waves of muscle contractions that push food through the bowels), which results in constipation. When calcium precipitates out in the kidneys and combines with phosphorous or oxalic acid, kidney stones are formed. Calcium can deposit in the lining of the bladder and prevent it from fully relaxing, and therefore from filling completely with urine. This leads to frequent urination problems, especially in older people.

Calcium can precipitate out of the blood and deposit in the lining of arteries, causing hardening of the arteries (arteriosclerosis). It can coat and stiffen cholesterol deposits

(plaque) in the arteries, leading to atherosclerosis. This, in turn, can cause blood pressure to rise as well as increase the risk of heart attack and stroke. Calcium can even deposit in the brain. Many researchers are investigating it as a possible cause of dementia, Alzheimer's, and Parkinson's disease.

Calcium can deposit in the lining of the bronchial tubes and cause asthma symptoms. Calcium in the extracellular fluid can surround cells in body tissue (organs, muscles) and decrease the permeability of the cell membranes. This makes it increasingly more difficult for glucose (a very large molecule) to pass through the cell membrane to be converted into ATP (adenosine triphosphate) in the cells' mitochondria. High glucose levels created by excess calcium may be misdiagnosed as diabetes.

ABSORPTION OF DIETARY MAGNESIUM IS HINDERED

Magnesium is ultimately absorbed into the bloodstream from the small intestine. At the best of times, only about one-half (down to as little as one-third) of the magnesium that is contained in food and water is absorbed; the rest is eliminated in the stool or urine. A study reported in *Metabolism* used radioactive magnesium to trace the activities of the mineral in the body.[9] It was observed that, on a diet with an average amount of magnesium, 44 percent of the ingested radioactive magnesium was absorbed; on a low-magnesium diet, 76 percent was absorbed; and on a high-magnesium diet, only 24 percent was absorbed. These results indicate that there is no need to fear an overload of magnesium in the diet. Any excess will be excreted harmlessly, whereas a deficiency could have serious consequences.

Some researchers say that we don't absorb more because we evolved on a diet that was high in magnesium from foods such as greens, nuts, seeds, and grains and so didn't need mechanisms to conserve it. That could be one of the underlying reasons that we are so deficient—our diet has betrayed us.

A number of other conditions also influence the degree of absorption:

- Whether the intestines are healthy or diseased
- Availability of the protein transport molecule for magnesium
- Availability of parathyroid hormone

- The rate of water absorption, because magnesium is soluble in water
- The amounts of calcium, phosphorus, potassium, sodium, and lactose (milk sugar) in the body, all of which inhibit magnesium absorption
- Supplemental iron, which can impede magnesium absorption and vice versa (if you take both, you should take them several hours apart)

Whether the intestines are healthy or diseased is probably the most important factor in magnesium absorption. Having written extensively on irritable bowel syndrome (IBS) and yeast overgrowth in *IBS for Dummies* (coauthored with L. Christine Wheeler, 2005) and *The Yeast Connection and Women's Health* (coauthored with William G. Crook, 2005), I have great concern about magnesium absorption in people who have a leaky gut—micropunctures caused by infection and injury to the intestinal lining that allow absorption of toxins into the bloodstream. The most common cause is overgrowth of the yeast *Candida albicans*, which normally lives largely unnoticed in the large intestine; when it moves into the small intestine, however, it sends out threadlike fibers that can create microscopic holes in the intestinal tissue, causing what's called "leaky gut." Yeast grows beyond its normal environment in the large intestine under the influence of antibiotics, cortisone and other steroids, birth control pills, estrogen, and a high-sugar diet. It produces up to 180 different by-products, most of which are toxins that can be absorbed through a leaky gut.

Yeast toxins, inflammatory substances the body produces as it tries to neutralize those toxins, and undigested food molecules all form barriers to the absorption of dietary and supplemental nutrients, including magnesium. I believe that IBS, yeast overgrowth, and food allergies must all be addressed in order to achieve optimal magnesium absorption. Reading about these conditions, investigating the use of appropriate nutritional products, and consulting with appropriate and knowledgeable experts may be necessary in order to develop a strategy to deal with these problems and ensure adequate magnesium absorption.

MAGNESIUM IS BLOCKED BY CERTAIN FOODS

It's important to know which foods are high or low in magnesium, but you should also know that certain foods contain chemicals that block absorption of magnesium. For example, there is much evidence that a high-protein diet only makes magnesium deficiency worse, and if you are following such a regimen, you should take at least 300 mg of supplemental magnesium.[10] Another potential source of problems is the tannin in tea, which binds and removes all minerals, including magnesium, from the body. If you suspect you are magnesium deficient, it's best to avoid both black and green tea, especially if they are strongly bitter. Less bitter teas do not contain such high amounts of tannins and may be less of a problem.

Oxalic acid, which is found in spinach and chard (among other foods), and phytic acid, found in the hulls of seeds and the bran of grains, can form insoluble compounds with magnesium and other minerals, causing them to be eliminated rather than absorbed. Cooking vegetables removes most of the oxalic acid, so steam spinach, chard, and other high-oxalic-acid vegetables instead of eating or juicing them raw. Preventing the binding action of phytic acid in grains and seeds is not so simple. Grains and seeds can be soaked for eight to twelve hours to remove the phytic acid, but few people make this effort. A diet high in grains is another reason to take magnesium supplements.

Soybeans, too, are high in phytic acid. Soy has one of the highest phytate levels of any legume and, unlike others, its phytic acid is not destroyed with extended cooking time. Only fermentation (as is done in the production of

miso and tempeh) will reduce the phytic acid levels of soy. This explains why I recommend only fermented soy and advise people to stay away from soy powders and soy milk as well as tofu, especially when these substitute for meat and dairy. As a cheap alternative to meat, soy (as soy protein isolate and textured vegetable protein) has exploded on the school lunch menu and in the fast-food industry. Too much soy can cause mineral deficiencies in children, who really need their minerals to build strong bones and teeth—the structures for adult health.

Moreover, menopausal women may be overusing soy (for its natural phytoestrogenic effects) and developing similar mineral deficiencies. While the phytoestrogens in soy may be helpful to older women, they are another reason to avoid using unfermented soy in the diets of growing boys and girls.

A JUNK-FOOD DIET LACKS MAGNESIUM

Even in a healthy diet with proper protein intake, the addition of 150 mg of elemental magnesium a day can make dramatic changes in health.[11] (See Chapter 18 for a full discussion of magnesium supplementation.) If even a good diet can leave you magnesium-deficient, a poor diet can seriously undermine your health.

We live in strange times, when people avidly watch gourmet-cooking shows while devouring junk food. Junk food provides 27 percent of most people's daily calories; an astounding 90 percent of our food dollar is spent on processed foods. People who drink soda and soft drinks may be magnesium-deficient because sugar uses up magnesium.[12], [13] Many carbonated beverages and processed foods (luncheon meats and hot dogs) contain phosphates, which bind with magnesium to make insoluble magnesium phosphate, which is not absorbed by the body.

DRUGS CAUSE MAGNESIUM DEFICIENCY

Ironically, one of the foremost magnesium experts, Mildred Seelig, M.D., began her research career in the 1960s working for drug companies. It was there she first noticed that many of the side effects of drugs were actually magnesium deficiency symptoms. It seemed to her that many drugs cause increased demand for and utilization of magnesium—for example, by creating acidity in the body, which then draws on available magnesium from the cells to try to neutralize the acid and minimize its toxic effects. Other drugs seemed to deplete magnesium from the body or, conversely, manifest their positive effects because they pulled magnesium from storage sites and increased the level of magnesium in the blood.[14]

The following commonly used drugs can create magnesium deficiencies:[15]

- Common diuretics (for high blood pressure)
- Bronchodilators, such as theophylline (for asthma)
- Birth control pills
- Insulin
- Digitalis (for some heart conditions)
- Tetracycline and certain other antibiotics
- Corticosteroids (for asthma)
- Cocaine
- Nicotine

DRUG INTERACTIONS WITH MAGNESIUM

Other drugs interact with magnesium in specific ways.[16] For example, magnesium is a muscle relaxant, so it enhances the actions of prescription muscle relaxants such as tubocurarine (used in surgery), barbiturates, hypnotics, and narcotics. These medications may be decreased under a doctor's supervision if you are on magnesium. In other words, you may not need as much muscle relaxant because magnesium is a natural relaxant. Tell your anesthesiologist before surgery if you are taking magnesium supplements.

Magnesium protects the kidneys, so supplementation may be beneficial during treatment with aminoglycoside antibiotics such as gentamicin and immunosuppressant drugs such as cyclosporin and cisplatin, which result in magnesium loss. Discuss this with your doctor.

Diuretics and cardiac drugs lower magnesium levels in the body. Diuretics throw off potassium, which is well known, but they also eliminate magnesium. Additional magnesium intake is recommended during administration of diuretics and cardiac glycosides such as digoxin. Check with your doctor.

Magnesium inhibits the absorption of iron, tetracycline, ciprofloxacin, vancomycin, isoniazid, chlorpromazine, trimethoprim, nitrofurantoin, and sodium fluoride. Take these medications two to three hours before or after magnesium supplements. (Sodium fluoride is prescribed for osteoporosis, although taking magnesium may be a wiser choice—especially since fluoride binds magnesium and makes it unavailable to the body. See Chapter 11 for more on osteoporosis.)

NUTRIENTS THAT NEED MAGNESIUM

- Both calcium and magnesium are required in order for either mineral to work properly in a variety of functions.
- Magnesium is necessary to convert the storage form of vitamin D into the active form.
- Magnesium enters cells with the support of vitamin B_1 (thiamine) and vitamin B_6 (folic acid).
- Selenium helps magnesium stay inside cells where it belongs.
- Zinc helps the absorption of magnesium.
- Vitamins D, A, and K, along with zinc and boron, work with magnesium for balanced bone health.
- Boron is essential for magnesium and calcium metabolism.
- Magnesium deficiency exacerbates a potassium deficiency.

MAGNESIUM WASTING

There are genetic causes of magnesium wasting, where the kidneys just can't seem to hold on to this vital mineral, but they are very rare. And some people require high amounts of this mineral because most is lost through the kidneys. I was surprised when at a recent seminar a doctor came up and thanked me for my talk on magnesium and said he suffered from magnesium wasting. He reported that in spite of having a good diet, taking supplements, and being on no magnesium-wasting drugs such as diuretics or digitalis, he still had slightly high blood pressure, moderately high cholesterol, and leg cramping. When he read the first edition of *The Magnesium Miracle* he realized his problem might be magnesium deficiency. But even when he took more, he still had some symptoms. That's when he decided to do a magnesium challenge test (see Chapter 16) and found out he was not retaining much magnesium at all, even after an IV challenge.

The doctor began taking regular IV treatments of magnesium. However, using picometer magnesium and spraying magnesium oil helps people who need high amounts of magnesium avoid the expense and inconvenience of IV magnesium.

WHY HAVEN'T WE HEARD ABOUT MAGNESIUM?

The vast majority of us were not exposed to nutritional education in school. But what about doctors? As you may suspect, doctors generally do not learn about nutrition or nutrient supplementation in medical school because they are studying disease, not wellness. When you visit a medical doctor, you may think you are going there to improve your health or prevent illness, but doctors have little time to educate their patients about how to keep themselves well. And patients often will not change their lifestyle unless their doctor tells them to, believing that if vitamins were so important, the doctor would have told them to take supplements. (Of course, some patients don't change the way they live even when their doctor does tell them they have to lose weight and eat right.) However, nutrition is not even a medical specialty. It wasn't when I went to medical school in the 1970s and it still isn't today! That's why you won't hear most of the information I report in this book from your doctor—because it's outside his or her field.

WHEN ALL YOU HAVE IS A HAMMER

In the first two years of medical school I learned all about diseases; the second two years I studied drug treatments for those diseases. We spent no time on nutrient deficiencies. Have you heard the expression "When all you have is a hammer, everything begins to look like a nail"? That is very much the case with doctors and drug treatments. But even worse, with thousands of drugs in the pharmaceutical compendium, it is quite impossible for doctors to keep up on the latest drugs, and impossible to prevent side effects or serious drug interactions. Studies show that most doctors are unable to recognize drug interactions and confuse them with a need to increase the dose rather than stop the drug. Although allopathic (conventional) medicine is said to be scientific, most patients are on more than one drug at a time, and there are *no* studies proving the safety of drug combinations.

According to magnesium expert Mildred Seelig, M.D., while a tremendous amount of magnesium research has been done in India, Britain, France, and other European countries, doctors in the United States use the excuse that not enough research has been done here for them to feel informed enough to prescribe it. Dr. Seelig calls this the "not-invented-here syndrome." Pioneers such as Drs. Bella and Burton Altura, however, continue to do original magnesium research in this country. Every year for the past forty years they have produced on average a dozen peer-reviewed journal articles on magnesium and Ionized Magnesium Testing. Their research convinces even die-hard skeptics—when they take the time to become informed—of

the clear need for magnesium supplementation and the absolute requirement for accurate testing.

DRUG COMPANIES FUND DRUG RESEARCH, NOT MINERAL RESEARCH

Medical science studies one symptom at a time, in isolation, and generally tries to find one cause for that symptom and one drug that treats it. The bias of medical research makes it search for a patentable drug that will eventually pay for the costly studies necessary to bring it to market. Everyone agrees that magnesium is indispensable for health, disease prevention, and all life processes, but it has been ignored because there is no profit to be made in selling a common nutrient. Magnesium cannot be patented, so pharmaceutical companies do not engage in magnesium research. There is no advertising budget for magnesium, compared to the hundreds of millions of dollars spent on advertising prescription drugs; nutrients do not get media attention. To make matters worse, over the past two decades the bulk of university funding has come from the pharmaceutical industry, which primarily funds drug research.[17] Scientific medicine ignores nutrient investigation in favor of drugs. Older research is also ignored by health providers. Doctors may have heard years ago that magnesium offered some promise in heart disease, but they haven't read any new studies, so they assume that the treatment must have not panned out.

Doctors seem to be waiting for a large clinical trial, for example, following twenty thousand people taking magnesium for life. It would have been nice if such a study had been initiated thirty years ago. Do we have the luxury of waiting for the results of such a study started now? No, we do not. Do we presently know enough about

magnesium to recommend widespread supplementation? Yes, we do.

An analysis of seven major clinical studies shows that intravenous magnesium reduced the risk of death by 55 percent after acute heart attack. These results were published in the prestigious *British Medical Journal* and the widely read journal *Drugs*.[18], [19]

As noted, Drs. Bella and Burton Altura have been researching magnesium and its clinical application for over forty years.[20] The ionized magnesium electrode, produced by Nova Biomedical of Waltham, Massachusetts, at the Alturas' urging, and tested at the State University of New York's Downstate Medical Center, has given doctors a reliable magnesium test and taken the guesswork out of diagnosing magnesium deficiency.[21] With such testing in hundreds of clinical trials the Alturas have been able to show that as many as twenty-one varied health conditions are related to magnesium deficiency. These are the conditions listed on this page and reported on in *The Magnesium Miracle*.

Dr. Alexander Mauskop, working with the Alturas, has proven the connection between migraines and magnesium many times over and puts magnesium treatment into practice at the New York Headache Center.[22], [23], [24] Dr. Mildred Seelig has contributed comprehensive reviews on magnesium at New York Medical College, the American College of Nutrition, and more recently at the Department of Nutrition, University of North Carolina.[25], [26] Dr. Jean Durlach, president of the International Society for the Development of Research on Magnesium (SDRM), editor in

chief of *Magnesium Research*, and professor at St. Vincent de Paul Hospital in Paris, has done extensive reviews of ongoing magnesium research.[27], [28]

All these magnesium experts agree that we must no longer sit on the sidelines or reserve judgment on the benefits of magnesium; we need to implement what we know, *now*.

PART TWO

MAGNESIUM-DEFICIENT CONDITIONS

CHAPTER THREE

ANXIETY AND DEPRESSION

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM, ANXIETY, AND DEPRESSION

1. Magnesium deficiency can produce symptoms of anxiety or depression, including muscle weakness, fatigue, eye twitches, insomnia, anorexia, apathy, apprehension, poor memory, confusion, anger, nervousness, and rapid pulse.
2. Serotonin, the "feel-good" brain chemical that is boosted by Prozac, depends on magnesium for its production and function.
3. Magnesium supports our adrenal glands, which are overworked by stress.

Each year millions of people are introduced to the merry-go-round of psychiatric drugs and psychological counseling for symptoms that may in fact be rooted in magnesium deficiency. Additional millions try unsuccessfully to cope

with their problems by turning to overeating, cigarettes, alcohol, street drugs, and other addictive behavior to suppress their pain. We are a nation suffering a 32 percent incidence of anxiety, depression, and drug problems. Social epidemiologist Myrna Weissman at Columbia University reports that more and more Americans are becoming depressed, getting depressed at a younger age, and experiencing more severe and frequent periods of depression. Each generation born in the twentieth century has suffered more depression than the previous one, and since World War II the overall rate of depression has more than doubled.[1], [2] A recent study in the *Archives of General Psychiatry* showed a doubling of depression in women from 1970 to 1992, with the use of psychiatric drugs skyrocketing as a result.[3]

People do not get anxiety, panic attacks, or depression because they have a deficiency of Valium or Prozac. Our bodies do not require these substances for essential metabolic processes. However, we can develop a myriad of psychological symptoms because of a deficiency of magnesium, a nutrient our bodies do require. Does it make any sense to merely switch our addictions from sugar, alcohol, drugs, and cigarettes to prescription medication without looking at the possible underlying metabolic causes? Psychiatrists all too often rely on prescription drugs for suffering patients and have no insight into the metabolic functioning of the mind and body and what happens when nutrients are deficient. Anxiety and depression are often nutrient-deficiency diseases and chemical sensitivities, certainly *not* drug-deficiency

diseases.

A remarkable study of almost 500 depressed people by Drs. Cox and Shealy found that the majority of sufferers were magnesium-deficient. The authors of the study advised clinicians that they should consider the distinct possibility of a therapeutic benefit from the use of magnesium therapy in chronic depression.[4]

ADRENALINE WASTES MAGNESIUM

It's not just a theory that stress causes magnesium deficiency and a lack of magnesium magnifies stress. Experiments where adrenaline is given intravenously produce a decrease in magnesium as well as calcium, potassium, and sodium. Without enough magnesium to relax arteries and muscles, blood pressure rises and the heart muscle cramps. When the IV adrenaline is stopped, the body recovers in about thirty minutes and potassium rises. However, it takes much longer for magnesium to reach normal levels.

There are over a dozen major metabolic processes that are affected by adrenaline, including heart rate, blood pressure, blood vessel constriction, and muscular contraction. Each of these functions requires magnesium and leads to wasting of this important mineral if the symptoms continue.

Darcy had driven across a mile-long bridge every day for years, so why one morning did she suddenly feel as though she would die if she didn't pull over? She was sweating and her heart was pounding; she felt sick to her stomach and couldn't get her breath. What was happening to her? Fortunately, she had her cell phone and called her best friend, Sara, who helped her calm herself and make her way across the bridge safely. Later, while talking with Sara to try to make sense of the episode, Darcy said she had been on a liquid protein diet for a few weeks. Sara pointed out that it could have thrown something out of balance, and she reminded Darcy that she had warned her of the dangers of this type of diet.

The two women reviewed the list of supplements that Darcy had been taking as part of the program and found that she had neglected to take the magnesium that had been suggested. Sara grabbed a natural health encyclopedia and, sure enough, magnesium deficiency was listed as one of the possible causes of panic attacks.

If Sara had read further, she would have found that the body demands more magnesium when on a liquid protein diet and that the dangers of such a diet have been documented for decades.[5] By eating only protein, Darcy had set herself up for a terrifying attack. Fortunately, she discovered this before pursuing a prescription for a tranquilizer to deal with the frightening symptoms of panic attack.

Lack of magnesium may not have been the only cause of Darcy's panic attack. As well as creating an extra demand for magnesium, her high-protein diet could have led to symptoms of hypoglycemia. When blood sugar (glucose) is low, the body reacts with a surge of adrenaline to bring glucose levels back to normal in order to keep this essential nutrient fueling the brain. Adrenaline acts to speed the heart and retrieve glucose from liver storage. Sometimes people perceive a normal adrenaline rush as a panic attack. Interestingly enough, magnesium is also a requirement for proper blood sugar control.

Women tend to pay attention to their feelings and interpret symptoms such as panic attacks as signs of emotional imbalance, for which they seek support. The support they get, however, is often in the form of a prescription for an antianxiety drug instead of sound advice

to eat a better diet, exercise, and take the right balance of supplements.

Magnesium deficiency can be an underlying cause of anxiety and depression, as determined in several clinical trials.[6] Symptoms of chronic magnesium deficiency include anxious behavior, hyperemotionality, apathy, apprehension, poor memory, confusion, anger, nervousness, muscle weakness, fatigue, headaches, insomnia, light-headedness, dizziness, nervous fits, the feeling of a lump in the throat, impaired breathing, muscle cramps (including leg cramps), a tingling or pricking or creeping feeling on the skin, rapid pulse, chest pain, palpitations, and abnormal heart rhythm.[7], [8] See the list of 100 possible symptoms and factors indicating magnesium deficiency on this page.

Even the hyperventilation that may accompany anxiety can further drop magnesium levels. Why is this? Hyperventilation makes the blood more alkaline, which must be neutralized with an intricate dance of sodium, potassium, calcium, and magnesium. It's much more unobtrusive, however, to take magnesium supplements for anxiety than to pull out a paper bag and breathe into it.

An important study in 1995 showed that even marginal magnesium deficiency could induce the brain to become hyperexcitable, as shown by EEG measurements. The study lasted six months, with thirteen women ingesting a total of 115 milligrams of magnesium daily, only 30 percent of the RDA, for the first three months, during which time their EEGs showed hyperexcitability. During the second three months, they received 315 mg daily—a little closer to the

360 mg RDA recommended for women. However, even on this low dose of magnesium (315 mg), it took only six weeks for EEG readings to show significant improvement in brain function and decreased excitability.[9]

ANXIETY

Stress is so prevalent in our daily life that we have become desensitized to it and the message it is trying to give us, which is to slow down. Anxiety is a chemical reaction created when the adrenal glands respond to a stressful event, such as low blood sugar, by releasing adrenaline. Adrenaline is very useful if you're trying to escape from a dangerous situation, because it stimulates the fight-or-flight response: the heart starts pumping faster; digestion slows down; energy stores are released from the liver and made available to the heart, lungs, and muscles; and the muscles of the arms and legs are activated. All of these responses require magnesium. So each time we experience any kind of stress, our magnesium stores are tapped to create energy. This magnesium depletion itself stresses the body, which can result in panic attacks, which equals yet more stress. Not only do our overworked adrenals cause magnesium depletion, but even more adrenaline is released under stress when magnesium levels are low in the body, leaving people feeling irritable, nervous, edgy, or even ready to explode. It's the proverbial Catch-22.[10] To put an end to anxiety, magnesium needs to be replaced.

During stress reactions, calcium is also required to stimulate the release of adrenaline, but calcium excess causes a flood of adrenaline. However, having sufficient magnesium will buffer excess calcium and keep it within normal levels, limiting the stress response. Magnesium is important because it naturally diminishes the excitability of the nervous system and lowers the level of calcium around nerve cells. This function of magnesium is also significant

in heart disease and other stress-induced illness.[11], [12]

CHRONIC STRESS

According to Hans Selye, the Canadian doctor famous for his work on stress in the 1960s, magnesium is also depleted when the body shifts from a short-term fight-or-flight reaction to a chronic stress reaction. The adrenal glands produce cortisol, a type of cortisone, and another stress hormone, norepinephrine, which acts like adrenaline and also causes magnesium depletion.

Chronic stress can come from feeling insecure and threatened, or from exposure to toxic chemicals, heavy metals, or even loud noise, all of which assault the nervous system and overwork the immune system. For example, constant loud noise in an industrial work setting induced a significant increase of serum magnesium (as magnesium was released from tissues) and significantly increased urinary excretion of magnesium, indicating a magnesium deficiency, which lasted for forty-eight hours after exposure.[13]

MAGNESIUM AND MUSICIANS

One case of sound-induced magnesium deficiency became evident to a parent who heard me talking about this condition on a New York radio station. She called in to the program and said that a few months after her son began playing in a rock band his left eyelid started to twitch uncontrollably. Listening to me on the radio show, she realized that it might be due to magnesium deficiency. Her son's twitching was likely a result of magnesium being used to buffer against the stress of sounds at a decibel level that sets off alarm bells in the body. Loud sounds cause a reflexive fight-or-flight response, and constant loud sound is not something the body gets used to and ignores—it must continually adapt to the noise, all the while using up valuable nutrients such as magnesium to do that job.

Exposure to loud music can increase urinary excretion of magnesium, which lasts for days after exposure. If magnesium is not replaced through an excellent diet and supplements, magnesium deficiency symptoms such as the 100 listed on this page may begin to appear. Although I do know some rock musicians who are vegetarians and don't smoke or drink alcohol, they may not be the norm. Smoking, coffee, alcohol, and the rock star lifestyle all contribute to magnesium deficiency.

Musicians have more than one reason to use magnesium. Nervousness, anticipation, and anxiety are all part of the buildup to a musical performance, whether it's classical, rock, punk, or rap. To deal with the anxiety and the resulting elevated heart rate that often accompanies it, musicians may feel they have to turn to drugs, alcohol, or

even medication. Inderal (propranolol) is a beta-blocker that is normally prescribed to treat high blood pressure and heart arrhythmias. However, it's also called "the musicians' underground drug" because it is used for performance anxiety. It's underground in the sense that it's not widely spoken about and also because anxiety is an off-label use of Inderal, which means that the FDA has not approved the drug for this use. However, there have been some small studies reporting that musicians felt better about their performance on beta-blockers.

What does Inderal do that makes it so attractive to musicians? Beta-blockers such as Inderal block physical reactions to fear. When your heart begins to race, your palms start to sweat, and you just want to run as fast and as far as you can, this describes the fight-or-flight response. Adrenaline is pumped from the adrenal glands to ready your muscles to run or fight. But what musicians need is to be calm, so that their hands don't slip off their instrument from shaking and sweating. They need their heart to stop thumping so loudly in their head that they can't hear their cue or even see the conductor or band leader. And for band leaders or conductors, the fear inherent in being responsible for the success of the performance is heightened even further.

Beta-blockers are used to decrease heart rate, but some of them, including Inderal, also cause constriction of the bronchial tubes, which makes them dangerous to use if you have asthma. They can also worsen congestive heart failure, diabetes, allergic reactions, and Raynaud's syndrome. Some people may have no side effects using small doses only on

rare occasions, but higher doses and becoming physically dependent on beta-blockers to calm you before every performance can take its toll.

Inderal is contraindicated in pregnancy and has the following side effects.

MOST FREQUENT
Decreased sexual function, drowsiness, fatigue, general weakness, insomnia

LESS FREQUENT
Abdominal pain with cramps, anxiety, bronchospastic pulmonary disease, chronic heart failure, constipation, depression, diarrhea, dizziness, nasal congestion, nausea, nervousness, sensation of cold, vomiting

RARE
Agranulocytosis, allergic reactions, anaphylaxis, arthralgia, back pain, chest pain, conduction disorder of the heart, dry eye, dysgeusia, erythema, erythema multiforme, exfoliative dermatitis, hallucinations, impaired cognition, laryngismus, leukopenia, nightmares, ocular irritation, orthostatic hypotension, pharyngitis, pruritus of skin, psoriasiform eruption, severe dyspnea, Stevens-Johnson syndrome, thrombocytopenic disorder, toxic epidermal necrolysis

Most musicians may not know all the side effects of Inderal; they take the medication because they need to, and they know lots of others who are doing the same. They may not realize that their sexual dysfunction, insomnia, and skin rash are due to the medication or that the medication removes the edge that adrenaline gives them. And for some, even if they do know, it's the price they pay in order to function in their profession. What they don't know is how much more effective and safe magnesium is for anxiety and stress. It can also function to increase energy and performance levels that Inderal may actually block. The absolute irony of using Inderal for anxiety is that it is known to reduce the levels of magnesium in the body, causing increased excretion through the urine. So if magnesium depletion is a cause of your anxiety, Inderal can make it worse. Another benefit of taking magnesium is reduction in the buildup of lactic acid that occurs after hours of playing. Repetitive motion injuries common to musicians can be eased by taking magnesium orally, using magnesium oil or gel on the injured arm or shoulder, and using homeopathic magnesium as needed. (See this page for more on homeopathic magnesium.)

The best oral form of magnesium for musicians is picometer magnesium. Put 1 tsp (after a week 2 tsp) in a liter of water and sip throughout the day. Other enhancements to performance include a good balanced diet to overcome any symptoms of hypoglycemia, which also causes anxiety; meditation and relaxation therapies; and yoga, swimming, walking, and other forms of exercise to increase circulation and burn off excess adrenaline. It is

inadvisable to suddenly stop using Inderal if you have been taking it regularly; check with your doctor about weaning off it as you increase your doses of magnesium and see the benefits.

MAGNESIUM-DEFICIENT KIDS

No, it's not just adults who can get anxious because of magnesium-deficient diets. Our children are also susceptible when their favorite foods are magnesium-deficient hot dogs, pizza, and soda. The stress in their lives —from peer pressure, academic and athletic performance pressures, worries about body image, the changes and hormonal fluctuations of puberty, exposure to negative events and violence through the media—also contributes. Even playing in a band can be a risk factor! Children are underdiagnosed when it comes to magnesium deficiency, but they can have magnesium deficiencies for the same reasons as adults. Attention deficit hyperactivity disorder (ADHD), autism, juvenile delinquency, and childhood depression are associated with magnesium deficiency, and some say these conditions can be caused by it.[14]

Dr. Sharna Olfman, a professor of clinical and developmental psychology, issues the following warning in her book *No Child Left Different:*

> The number of American children being diagnosed with psychiatric illnesses has soared over the past decade and a half. The National Institute of Mental Health (NIMH) estimates that today, one in ten children and adolescents in the United States "suffers from mental illness severe enough to result in significant functional impairment." During this same time period, psychotropic drugs have become the treatment of first choice rather than the treatment of last

> resort. Recent years have witnessed a threefold increase in the use of psychotropic medication among patients under twenty years of age, and prescriptions for preschoolers have been skyrocketing. Over 10 million children and adolescents are currently on antidepressants, and about 5 million children are taking stimulant medications such as Ritalin.[15]

In 2005, Columbia University initiated a program called Teen Screen throughout forty states, which screened teens and children for mental health problems. Unfortunately, such screening usually leads to the prescribing of more drugs. Instead of reaching for Ritalin or Prozac for kids, consider whether they're getting enough magnesium first. In fact, if these children were simply taken off sugar and put on magnesium, we would have much happier children and thus far fewer side effects from powerful drugs.

Dr. Leo Galland, author of *Superimmunity for Kids*, speculates that hyperactive children need extra magnesium due to their constantly high adrenaline levels. Dr. Galland recommends 6 mg per pound of weight per day (for example, 240 mg for a 40-lb child). Because magnesium in pill form is difficult for young children to take, he suggests 1 tsp to 1 tbsp of magnesium citrate a day.[16] Since there may be a concern about a laxative effect with this amount have your child take several smaller doses of magnesium citrate several times a day and be sure not to take it all in one dose. I recommend the nonlaxative picometer magnesium, ReMag, ¼ tsp twice a day. You can also put it

in a spray bottle to use transdermally.

SEROTONIN, MAGNESIUM, AND DEPRESSION

You may be familiar with serotonin, the body's natural "feel-good" brain chemical. Magnesium is important in the serotonin story because it is a necessary element in the release and uptake of serotonin by brain cells. With proper amounts of magnesium, nature makes sufficient serotonin and you experience emotional balance. But when stress depletes magnesium, a vicious cycle spins out of control, and depression can occur. The body needs magnesium in order to release and bind adequate amounts of serotonin in the brain for balanced mental functioning.

The pharmaceutical industry has focused its research for the treatment of depression on selective serotonin reuptake inhibitors (SSRIs), such as Prozac, to capitalize on serotonin's chemical effects instead of giving serotonin what it really needs—magnesium. SSRIs create artificially elevated levels of serotonin in the body by preventing its breakdown and elimination; serotonin lingers longer in the brain and theoretically causes mood elevation. This is what is *supposed* to happen, but everyone has a different reaction to the manipulation of their brain chemicals. For some people, prolonged, rising levels of serotonin can liberate them from a long depression. For others, the drug can lead to anxiety and irritability. A small but significant group can feel released from their apathy and act on suicidal or homicidal thoughts. Another group of people tend to have flattened moods in which they can neither weep nor laugh, keeping them from the extremes of depression or mania but relegating them to a one-dimensional life.

This was Maggie's situation. She was on Prozac and desperately trying to come off it because she was unable to cry or experience real emotions. Maggie was down to one-quarter of a 10 mg tablet but was afraid to stop in case her depression came back. She also had high blood pressure, high cholesterol, periodic muscle cramps, and constipation. I asked her to have her magnesium tested, and her cardiologist said it was normal; he said she didn't need magnesium but should continue to take her five prescription medications to control her symptoms. She called me when her GP thought her worsening muscle cramps were a major blood clot in the leg. We didn't have time to ship a blood sample to the lab that performs Magnesium RBC testing, so I encouraged her to take 300 mg of magnesium twice a day and go for a Doppler scan to rule out blood clots. Fortunately, the scan was negative, so Maggie was able to avoid several more medications to treat blood clots, and the magnesium was already working to relieve her symptoms. Within a few weeks Maggie was finally off the last small amount of Prozac and able to laugh and cry again.

TREATMENT FOR ANXIETY AND DEPRESSION

DIET

Avoid food additives, artificial sweeteners, sugar, and wheat. Eat a whole-foods diet—organic, if possible—and avoid processed and junk food. Also read *The Yeast*

Connection and Women's Health (Crook and Dean, 2005) and *IBS for Dummies* (Dean and Wheeler, 2005) since both yeast and IBS are associated with anxiety and depression. Understanding and treating these conditions under the supervision of a knowledgeable practitioner can enhance use of the following supplements.

SUPPLEMENTS

ReMag: (Picometer-ionic) 150 mg 2–3 times a day and/or

Magnesium citrate: 300 mg twice a day

Calcium: dietary and/or bone broth 700mg (see this page for food lists and this page for bone broth recipe)

B complex: Food-based, Grown by Nature

Tryptophan: 500 mg, 1–2 at bedtime on an empty stomach. (This amino acid is converted into serotonin; acts like Prozac but has no side effects.)

St. John's wort: 300 mg standardized extract 3 times a day

SLEEP AIDS

Melatonin: 2–3 mg one hour before bedtime

5-hydroxytryptamine (5-HTP): 50–200 mg half an hour before bedtime, on an empty stomach

Hops, valerian, and skullcap herbal combinations: one or two 500 mg capsules before bedtime

STRESS RELEASE

Exercise is excellent for treating both anxiety and

depression (try yoga, walking, biking, Pilates, T-Tapp, and swimming), as are prayer, meditation, long baths, journal writing, and Emotional Freedom Techniques (EFT).

Because depression can be so debilitating, even life-threatening, it's understandable that doctors feel strong measures are required to combat it, but these strong measures don't always work. The alternative that many doctors are missing is the nutrient connection. Magnesium deficiency is a potential cause for every type of depression. All treatment protocols should begin with adequate doses of this valuable mineral.[17]

CHAPTER FOUR

MIGRAINES AND PAIN

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM AND MIGRAINES

1. Magnesium prevents platelet aggregation, which helps to avoid the thickened blood and tiny clots that can cause blood vessel spasms and the pain of a migraine.

2. Magnesium relaxes the head and neck muscle tension that makes migraines worse.

3. Magnesium, vitamin B_2, and the herb feverfew are an important migraine treatment combination.

Martha knew that a migraine was looming when the sparks and wavy lines appeared before her eyes. Working became impossible, and she knew she would be looking at the loss of at least one day to a severe migraine attack. Medications such as codeine and ergotamine had not helped her over the years, instead making her feel drugged and tired after the headache finally passed. And the fancy new drugs

Imitrex, Depakote, and Midrin did nothing for her head pain but did give her chest pain and make her more sick to her stomach. All Martha could do was lie in a darkened room with a cool cloth over her eyes, too nauseated to eat. This time, however, instead of trying to keep hydrated with lots of diet soda, as she usually did, she was going to drink mineral water with lemon and natural fruit juice.

Martha's daughter Mary, a nurse, had told her that aspartame, the sweetener in diet soda, causes headaches. Even though Martha loved her diet pop—she suspected that she was addicted to it, drinking two liters a day on average—she knew she had to do something to stop these headaches, both the daily ones and the one or two migraines a week.

Over the next few days, Martha's skin itched and she was nauseated, dizzy, and depressed. She thought she was having a reaction to the medication she had taken for her migraine, but Mary told her she was going through aspartame withdrawal. She was also having strong cravings for her diet soda, but Mary insisted that she stay off it. Mary did some more research on aspartame and how to cope with withdrawal and brought her mother a bottle of magnesium citrate supplements. The 150 mg three times a day seemed to help right away. By the next week, Martha's head felt clearer; she was more alert and less achy. She hadn't even realized that her joints and muscles had been tight and sore until she no longer had those symptoms. To her great relief, two weeks after eliminating aspartame from her diet, she realized that she hadn't had one of those headaches that she used to get daily. After two months of

strictly avoiding aspartame, she still had no more headaches or migraines, except once after she had eaten something she had not known contained artificial sweetener. That convinced her even more that, for her, aspartame was poison.

ASPARTAME AND MSG: EXCITOTOXINS

Aspartame is, in fact, an excitotoxin, one of a group of substances, usually acidic amino acids, that in high amounts react with specialized receptors in the brain, causing destruction of certain types of neurons.

A growing number of neurosurgeons and neurologists are convinced that excitotoxins play a critical role in the development of several neurological disorders, including migraines, seizures, learning disorders in children, and neurodegenerative disorders such as Alzheimer's disease, Parkinson's disease, Huntington's disease, and amyotrophic lateral sclerosis (ALS).[1] Glutamate and aspartate are two powerful amino acids that act as neurotransmitters in the brain in very small concentrations, but they are also commonly available in food additives. Glutamate is in MSG, a flavor enhancer, and in hydrolyzed vegetable protein, found in hundreds of processed foods. Aspartate is one of three components of aspartame (NutraSweet, Equal), a sugar substitute. In higher concentrations as food additives, these chemicals constantly stimulate brain cells and can cause them to undergo a process of cell death known as excitotoxicity—the cells are excited to death.

HYPOGLYCEMIA

The brain becomes extremely vulnerable to excitotoxins during episodes of low blood sugar or hypoglycemia. Pound for pound, the brain uses more blood sugar than any other part of the body. Low blood sugar occurs when you are malnourished or even when you skip meals. It also occurs in individuals whose adrenal glands are depleted and can't mount the necessary adrenaline response to raise blood sugar when it gets too low. Magnesium is responsible for balancing blood sugar. With sufficient magnesium and balanced meals to prevent low blood sugar, you can protect yourself against headaches, attention deficit hyperactivity disorder, mood disorders, and even premenstrual tension. Supporting the brain as much as possible with safe nutrients and a safe environment, you may never need the brain-altering medications that are prescribed for these disorders.

Medically, hypoglycemia occurs when blood sugar (glucose) drops to a low of 50 mg/dl (normal is about 80–110 mg/dl). If you eat a highly refined diet with lots of white sugar and white flour, foods whose carbohydrates are rapidly absorbed into the bloodstream, your blood sugar will quickly become elevated; when it reaches a certain maximum, insulin enters the bloodstream and quickly ushers the excess glucose into the cells of the body, causing your blood sugar to drop. The more sugar you eat and absorb, the more insulin is released and the quicker your blood sugar can fall. This abrupt drop causes adrenaline to be released from the adrenal glands to make sure that the blood sugar does not fall so low that you faint. When that

adrenaline mobilizes the sugar stores in the liver to elevate your blood sugar, however, it also produces a fight-or-flight reaction, which may give you a sense of anxiety or impending doom. It may even feel like a panic attack because you don't equate your symptoms with low blood sugar. At this point, if you eat something to pick you up or comfort you, such as a candy bar or an aspartame-containing diet drink, or if you are exposed to other environmental toxins, your glucose-deprived, magnesium-deficient brain will be more vulnerable to the effects of the excitotoxins. Many diseases of the nervous system are being associated with excitotoxin buildup in the brain, including migraines, seizures, strokes, and brain injury.

If you have magnesium deficiency and regularly use aspartame, the toxicity is magnified and can result in headaches and migraines. You can easily identify whether your headaches are caused by aspartame: give yourself sixty days without any aspartame and judge for yourself. And if you want to minimize the withdrawal effects, take 150 mg of elemental magnesium three or four times a day (see this page for more on dosages).

Magnesium helps prevent the chain of events that causes cell death due to low blood sugar and exposure to other toxins besides excitotoxins. One of the most important neuroprotectants known, magnesium helps defend our cells against potential neurotoxins in our environment, such as pesticides, herbicides, food additives, solvents, and cleaning products.[2] Drs. Michael and Mary Dan Eades, authors of *Protein Power*, state that if they had only one supplement to give their patients, they would choose

magnesium above all others.[3] In Chapter 13 we will talk more about the myriad toxins to which we are subjected on a daily basis, how we can avoid them, and how magnesium can protect us from harm.

MIGRAINE MECHANISMS

Twenty-five million Americans suffer from migraines. Statistically, women have more migraines than men, especially in the twenty-to-fifty-year age group. The following biochemical events involving low magnesium have been identified in migraine sufferers and may set the stage for a migraine attack.[4]

- In nonmenopausal women, estrogen rises before the period, causing a shift of blood magnesium into bone and muscles. As a result, magnesium levels in the brain are lowered.
- When magnesium is low, it is unable to do its job to counteract the clotting action of calcium on the blood. Tiny blood clots are said to clog up tiny brain blood vessels, leading to migraines. Several other substances that help create blood clots are increased when magnesium is too low.
- Low brain magnesium promotes neurotransmitter hyperactivity and nerve excitation that can lead to headaches.

Several conditions that trigger migraines are also associated with magnesium deficiency, including pregnancy, alcohol intake, usage of some diuretic drugs, stress, and menstruation. Magnesium deficiency is related to migraines in so many ways.

- Magnesium relaxes blood vessels and allows them to dilate, reducing the spasms and constrictions that can

cause migraines.

- Magnesium regulates the action of brain neurotransmitters and inflammatory substances, which may play a role in migraines when unbalanced.
- Magnesium inhibits excess platelet aggregation, preventing the formation of tiny clots that can block blood vessels and cause pain.
- Magnesium relaxes muscles and prevents the buildup of lactic acid, which, along with muscle tension, can worsen head pain.

A group of 3,000 patients given 200 mg of magnesium daily had an 80 percent reduction in their migraine symptoms.[5] This study did not have a control group, so the results could be questioned, but it aroused a great deal of excitement and triggered a flurry of research on magnesium and migraines. Much of that research was done by Dr. Alexander Mauskop, director of the New York Headache Center, working with Drs. Bella and Burton Altura, who have been studying migraines and migraine treatments for about ten years. Their research team consistently found that magnesium is deficient in people with migraine and many other types of headache and, even more important, that treating the deficiency alleviates the headache.

Dr. Mauskop with the Drs. Altura undertook many research studies using sensitive magnesium ion electrodes.[6] During one of the first studies they found a deficiency in magnesium ions but not serum magnesium in migraine patients.[7] This discrepancy shows the lack of correlation

between magnesium-deficient states and serum magnesium. This is because only 1 percent of the magnesium in the body is found in the blood (serum). A measurement of magnesium ions, the actual working magnesium, is much closer to the total amount of magnesium in the body.

When migraine sufferers with low magnesium ion levels were given intravenous magnesium, they experienced a complete alleviation of their symptoms, including sensitivity to light and sound.[8] Subsequent studies of migraine patients confirmed a common pattern and support a role for magnesium deficiency in the development of headaches.[9] The researchers found that infusion of magnesium resulted in a rapid and sustained relief of acute migraine. Because of an excellent safety profile and low cost, they recommend oral magnesium supplementation for migraine sufferers at a level of 6 mg/kg/day.[10]

Patients with cluster headaches, a very severe form of recurrent headache, have also been reported to have low magnesium ion levels. Some people suffer up to twenty bouts of pain daily in a siege that can last for months. Another study from Altura, Altura, and Mauskop examined the possibility that patients with cluster headaches and low magnesium ion levels may respond to an intravenous infusion of magnesium sulfate. Within fifteen minutes of an intravenous dose of magnesium, nine patients with cluster headaches had their acute headache aborted.[11] Blood ionized magnesium testing thus proves to be useful in elucidating the cause of cluster headaches and in identifying patients who may benefit from treatment with magnesium,

much as it does for migraines.[12]

Another research team treated eighty-one patients who suffered ongoing migraine headaches with 300 mg of magnesium twice a day. The frequency of migraines was reduced by 41.6 percent in the magnesium group but by only 15.8 percent in a control group that received placebos. The number of migraine days and drug consumption for pain also decreased significantly in the magnesium group. High-dose oral magnesium appears to be effective in migraine treatment and prevention.[13]

SUPPLEMENTS FOR MIGRAINE

Identify food allergies that may trigger migraines

ReMag: (Picometer-ionic) 150 mg 2–3 times a day and/or

Magnesium citrate: 300 mg two or three times per day

Calcium: dietary and/or bone broth, (see this page for food lists and this page for bone broth recipe)

Vitamin B_2 (riboflavin): 50 mg twice per day

Vitamin B complex: 2 per day. Food-based, Grown by Nature (take the complex to prevent imbalances from taking large amounts of one B vitamin)

Feverfew (*Tanacetum parthenium*): 100 mg per day

Stress therapies

Regular exercise

Aspirin has been used to treat headaches for decades. Magnesium-buffered aspirin, however, is preferred by heavy users. (Could magnesium be responsible for some of its beneficial effects? The same question applies to buffered aspirin used in heart disease.)

In Dr. Mauskop's *What Your Doctor May Not Tell You About Migraines* he outlines his "triple therapy" for migraines. It includes magnesium, vitamin B_2 (riboflavin), and a well-known migraine herb, feverfew.

MUSCLE PAIN AND SPASMS

A patient came for a consultation and wanted a total body X-ray because she was having such severe episodes of pain—her whole body would go into spasm—that she thought she must have cancer. I asked her to try taking 300 mg of magnesium three times a day. Within three days she no longer had the spasms, and after three weeks she was free of pain.

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM AND MUSCLE PAIN

1. Magnesium helps muscles relax.
2. Magnesium eliminates spasms.
3. Magnesium relaxes blood vessels in the fingers to treat Raynaud's syndrome.

Although this patient did not have cancer, research has shown that even the pain of cancer can respond to magnesium. Cancer sometimes metastasizes into nerve bundles located in the neck or lower back and may not respond to even the strongest analgesics such as morphine. There is a special receptor site called NMDA that is responsible for creating this type of nerve pain; magnesium helps block this receptor. In cases of severe pain, intravenous magnesium has shown very powerful analgesic

effects.[14]

Muscle twitches, tics, and spasms may seem like minor irritations to the onlooker, but to the person suffering, it's like water torture—only instead of water slowly dripping on your forehead, your eye or lip or a small muscle in your leg may constantly jump and writhe. Muscle twitches are a sure sign of magnesium deficiency. The nervous system is hyperexcitable and fires off small muscle groups to try to release some tension. But the only way to eliminate muscle spasms and twitches is by relaxing the nervous system with the proper amounts of magnesium.

RAYNAUD'S SYNDROME

Sally had terrible leg cramps. During the night, her legs felt jumpy and twitchy and kept her awake. If she did fall asleep, muscle cramps in her calf would wake her up. In addition, her fingers began turning white, blue, or red at different times. A young internist diagnosed her as having Raynaud's syndrome, a circulatory condition caused by the spasm of tiny arteries, especially in the hands and feet.

Raynaud's syndrome may occur suddenly or as a result of other chronic illnesses such as connective tissue disease, trauma, or pulmonary hypertension, in which cases it is called Raynaud's phenomenon. Raynaud's syndrome is seen mostly in young women and rarely leads to damage of the extremities. Cold is often the only stimulus that initiates the blood vessel spasms, which may last from minutes to hours. Emotional stress can also play a role in bringing on an attack. Besides the noted color changes there can be agonizing pain, especially when the fingers are rewarming. Symptoms of tingling, numbness, and burning are common. Many people who have this condition just put up with it. Even if they consult their doctors for a diagnosis, there is no safe, effective drug treatment for it (sometimes calcium channel blockers are used).

Fortunately, Sally's internist knew that magnesium is the most effective treatment for both muscle cramps and Raynaud's because it improves circulation, stops spasms, and minimizes stress reactions. He put her on magnesium, 300 mg twice a day, a food-based multiple vitamin and mineral, and dietary calcium.

It took three months for the Raynaud's to respond, but

Sally couldn't believe how much better she felt in the meantime. The muscle cramps improved within a week, and symptoms that she had thought were just part of getting old dramatically improved. Her energy increased, as she was able to sleep better. Her bowel movements were also more regular, and she was much calmer than she had been in a long time.

Nutritional recommendations for Raynaud's include liver-cleansing foods such as beets, dandelion greens, burdock root, and lemons, and foods rich in magnesium, including nuts, seeds, green vegetables, and whole grains. Foods to avoid or reduce to lessen the symptoms of Raynaud's syndrome include meat, alcohol, spices, and fatty, rich, fried, or salty foods.

SUPPLEMENTS FOR RAYNAUD'S

ReMag: (Picometer-ionic) 150 mg 2–3 times a day and/or

Magnesium citrate: 300 mg twice per day

Calcium: dietary and/or bone broth 700 mg (see this page for food lists and this page for bone broth recipe)

Vitamin E as mixed tocopherols: 800 IU per day

Evening primrose oil: 6 capsules per day

Vitamin B_3: as niacin, 100 mg 3 times a day (increases circulation to the extremities)

Quercetin (a bioflavonoid): 500 mg per day

TOURETTE SYNDROME

Tourette syndrome was first defined in 1885 by a French physician. It is characterized by violent muscle contortions called motor tics and vocal disruptions combined with outbursts of swearing or obscenities. The vocal tics occur in only 5–15 percent of patients. Tourette syndrome itself was thought to be a rare condition; however, the National Institutes of Health report that the prevalence of Tourette syndrome is substantially higher than previously estimated.[15]

The NIH also reports that Tourette syndrome is associated with obsessive-compulsive disorder, ADHD, and learning problems in children who also have tics and rage attacks. A gene or genes responsible for Tourette syndrome have yet to be found.

The muscle contortions that characterize Tourette syndrome are increased by stress and associated with anxiety, depression, and sleep disorders. Since all these associated conditions are affected by magnesium, it only makes sense to look at magnesium deficiency as a possible cause. Research has defined the central role of magnesium deficiency in Tourette syndrome, and this bears further investigation.[16]

MAGNESIUM AND EXERCISE

When your muscles are engaged in the rapid-fire contraction and relaxation of physical exercise, if there is too much calcium (the initiator of contractions) and too little magnesium (the initiator of relaxation), muscle cramps and a buildup of lactic acid can result. Even though most athletes and coaches don't know it, magnesium is one of the most important nutrients athletes can possibly take.

As noted earlier, cells use energy packets called ATP (adenosine triphosphate), which are formed under the influence of magnesium. Some of the first studies showing the relationship between magnesium and physical performance were done on animals and found that decreased exercise capacity can be an early sign of magnesium deficiency. When the animals were given magnesium dissolved in water, their endurance was restored. Most human studies also confirm that both brief and extended exercise deplete magnesium.

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM AND EXERCISE

1. Magnesium reduces lactic acid, which causes post-exercise pain.
2. Magnesium is lost during exercise.
3. Magnesium deficiency may cause sudden cardiac death in healthy athletes.

One of the most amazing effects of magnesium on the neuromuscular system is that it provides more energy, even though the mineral generally acts as a relaxant and not a stimulant. If you are magnesium-deficient, your energy level will be low because you aren't producing the necessary energy to run your body. When you start taking magnesium, your energy level goes up. Magnesium's interactions with calcium help keep calcium from causing excessive muscle contraction. Excess calcium causes tension and tightness in all the muscles of the body, but when you take a balancing amount of magnesium, this tension releases within weeks, days, or even hours, depending on the underlying level of magnesium deficiency in your body.

Exercise is often prescribed therapeutically for anxiety and depression—to burn off steam (so to speak), to increase the circulation, and to get adrenaline pumping. Magnesium allows the body to burn fuel and create energy in an efficient cycle during exercise that does not lead to lactic acid production and buildup. For some individuals who exercise excessively or suffer from chronic fatigue syndrome, painful amounts of lactic acid build up in their muscles, making exercise an unpleasant experience. Exercise itself places stress on your body, to which your adrenal glands respond by pumping out adrenaline.

Heavy exercisers, especially long-distance runners, can build up lactic acid and suffer shin splints and painful muscles, but they keep on running because they may be addicted to the adrenaline rush they get when they reach

“the wall” in their workout. The wall feels like something you just can’t break through, but you keep on pushing, and suddenly you get a burst of adrenaline and you’re flying. That’s the power of your adrenal glands when pushed to the maximum. Yet that stress-induced high is followed by a crash when you don’t repair the damage to your adrenal glands with good nutrition and restore the magnesium that was lost during exercise.

Many studies have shown that magnesium supplementation enhances the performance and endurance of long-distance runners, cross-country skiers, cyclists, and swimmers. It also reduces lactic acid buildup and post-exercise cramps and pain. Since athletes undergo severe physical stress as well as the psychological drive to win, and most ingest suboptimal amounts of magnesium, they are vulnerable to magnesium deficiency.[17]

Years ago the coach of a Florida high school football team was concerned about his players’ frequent complaints of leg cramps, so he gave them a calcium supplement on a very hot day before a rigorous game. Early in the second half, eleven players became disoriented and had difficulty walking. Their speech was slurred, they complained of muscle spasms, and they were breathing very deeply. Within an hour, eight of the boys collapsed into full-blown seizures; two had repeated seizures. Those having the worst symptoms had been playing the hardest. Thirteen more players reported headaches, blurred vision, muscle twitching, nausea, and weakness.[18] Eventually all the boys recovered, but what happened to create such a frightening scene in this group of healthy young men? Consider the

facts. Those that were affected had all eaten a pre-game magnesium-deficient fast-food meal consisting mainly of carbohydrates and fats, and sodas containing phosphoric acid. With the increased magnesium loss from excessive sweating plus the calcium supplement, their magnesium stores had been driven dangerously low.[19]

Magnesium deficiency may also play a role in sudden cardiac death syndrome, which can affect athletes.[20] In a study of young, healthy, well-conditioned men, strenuous effort was reported to give rise to persistent magnesium deficiency and a related long-term increase in cholesterol, triglycerides, and blood sugar. This study postulates that the sudden death of athletes and other intensely training individuals during extreme exertion is triggered by the detrimental effects of persistent magnesium deficiency on the cardiovascular system.[21], [22]

MAGNESIUM SUPPLEMENTS FOR EXERCISERS AND ATHLETES

Dr. Seelig, an internationally recognized magnesium specialist, recommends that athletes in training obtain at least 6–10 mg/kg/day (or 2.7–4.5 mg/lb/day) of magnesium to help replace the losses from exertion, sweating, and stress.

For a 220-lb man: 600–1,000 mg per day
For a 150-lb woman: 400–680 mg per day

These doses can be cut by 150 mg for people who exercise moderately (one to two hours a day).

CHAPTER FIVE

STROKES, HEAD INJURY, AND BRAIN SURGERY

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM AND THE BRAIN

1. Magnesium protects the brain from the toxic effects of chemicals such as food additives.
2. Magnesium keeps calcium out of cells; when magnesium is low, calcium rushes in, causing cell death.
3. When blood sugar and magnesium are both low, the glutamate in MSG enters brain cells, causing cell death.

Magnesium does much more than any drug to protect the blood circulation and the brain:

- It's a vasodilator, opening up blood vessels.
- It protects the endothelium, or inner layer of blood vessels.
- It closes the calcium channel to excessive calcium

influx.

MAGNESIUM-DEFICIENT BRAINS

With most of the U.S. population deficient in magnesium,[1] many Americans are at greater risk for a host of serious problems, including stroke with severe poststroke complications, depending on the degree of magnesium deficiency; poor recovery from head injury with escalating neurological damage; neurotoxin damage from vast numbers of chemicals in our air, food, and water; seizure disorders; Alzheimer's disease; and Parkinson's disease.[2] These conditions are the neurological equivalent of heart disease. After all, both heart and brain are excitable tissues that give off electrical energy, and both must have magnesium. The complexity of the mechanisms of central nervous system hyperexcitability due to magnesium deficiency is only now being appreciated.[3]

HEAD INJURY AND MAGNESIUM

Traumatic brain injury (TBI) is a major public health problem throughout the world. There are more than 400,000 patients with TBI in the United States alone. From animal studies, we know that brain magnesium levels fall dramatically at the site of injury as this mineral is depleted in a cascade of events.[4] In sixty-six human subjects with acute blunt head trauma, the greater the degree of injury, the greater the calcium-ion-to-magnesium-ion ratio.

Such findings provide evidence of magnesium ion changes in the blood after traumatic brain injury, which could be of both diagnostic and prognostic value.[5] Studies of both animals and human brain trauma victims suggest that higher magnesium levels are associated with a better recovery.[6] Giving sufficient magnesium will create a better healing outcome. Magnesium sulfate significantly reduces brain edema following brain injury and is used to treat patients with severe TBI without adverse effects.[7] This is crucial information to give your doctor if your child suffers a head injury or any family member is involved in a motor vehicle accident.

Ionized Magnesium Testing, used in research studies, makes the diagnosis of posttraumatic headaches much easier. Abnormalities in magnesium ion concentration and the calcium-ion-to-magnesium-ion ratio were found in children with posttraumatic headaches, but serum magnesium levels were normal.[8] Obviously, studies using only the serum magnesium test would miss the diagnosis and fail to properly treat these patients. See Chapter 16 for a full discussion of magnesium testing.

A magnesium deficit from head injury is slow to reverse. According to neurosurgeon Dr. Russell Blaylock, magnesium takes thirty minutes to get into the spinal fluid, three hours to reach the cortical area directly under the skull, and a full four to six hours for sufficient amounts of magnesium to reach the deep brain tissues. Experiments with Navy SEALs and marathon runners show that after a month of intensive training, they experience magnesium deficiency and, if no supplements are taken, the deficiency is still present three to six months later. It only makes sense that if your diet is deficient and you're under stress, physical or emotional, you need to replace your magnesium stores daily.

BRAIN INJURY, ALCOHOL, AND MAGNESIUM

Drs. Bella and Burton Altura discuss the direct cause-and-effect relationship between alcohol-induced headache and risk of brain injury and stroke in one of their numerous papers.[9] They note that binge drinking of alcohol is associated with an ever-growing number of strokes and cases of sudden death, with alcohol causing spasm and rupture of the cerebral arteries.[10] In animal studies, high doses of alcohol caused a rapid fall in levels of magnesium ions in the brain and an elevation of calcium, followed by cerebral vessel spasm and rupture of cerebral blood vessels (stroke).[11], [12] People who consume more than three alcoholic drinks a day can be deficient because alcohol blocks magnesium absorption.[13] In human studies, people with mild head injury have been found to exhibit early deficits in magnesium ions; the greater the degree of head injury, the greater and more profound the deficit in magnesium ions, and the greater the level of calcium ions compared to magnesium ions. Patients with histories of alcohol abuse or ingestion of alcohol prior to head injury exhibited greater deficits in magnesium ions (and higher calcium-ion-to-magnesium-ion ratios) and, unlike the subjects without alcohol, remained in the hospital at least several days longer. Data on 105 men and women with different types of stroke indicate that, on average, a 20 percent deficit in magnesium ions is seen, while serum magnesium is usually normal.[14]

As pointed out many times previously and also in Chapter 16, serum magnesium is a highly inaccurate measurement of the body's magnesium because only 1

percent of the magnesium in the body resides in the blood. The Alturas also report that in other human studies, it has been shown that the migraines, headache, dizziness, and hangover that accompany alcohol ingestion are associated with rapid deficits in magnesium ion levels but not in serum magnesium, which obscures the diagnosis if only serum magnesium is measured. And since magnesium is necessary to regulate calcium, its deficiency creates calcium-induced vascular spasms and pathology.[15] Alcohol-associated headaches can be treated with intravenous administration of magnesium sulfate.[16] Premenstrual tension headache and its exacerbation by alcohol in women is also accompanied by deficits in magnesium ions and elevation in the calcium-ion-to-magnesium-ion ratio, and can be corrected by intravenous magnesium sulfate.

STROKE

A burst or clot-blocked blood vessel in the brain is all it takes to cause a stroke. The damage in so confined a space destroys critical brain functions. Stroke is said to be caused by hypertension, atherosclerosis, and diabetic complications—all of which are associated with low magnesium. Keeping blood vessels strong, preventing blood from clotting inappropriately, and even healing stroke-damaged areas are all within the scope of the miracle of magnesium.

Stroke has devastated the lives of 4.6 million Americans and 15 million people worldwide. Each year about 700,000 new strokes occur, along with 100,000 recurrences —and statisticians say that the incidence of stroke is on the rise.

What evidence is there of the importance of magnesium in stroke? All deaths due to stroke among Taiwan residents (17,133 cases) from 1989 through 1993 were compared with deaths from other causes (17,133 controls). It was determined that the higher the magnesium levels in drinking water used by the Taiwan residents, the lower the incidence of stroke.[17]

Animal experiments show that intravenous magnesium can prevent alcohol-induced hemorrhagic stroke and the subsequent fall in brain magnesium ion level as well as other metabolic factors.[18] Recent data indicate that alcohol-induced cellular loss of magnesium ions is associated with cellular calcium overload and generation of free radicals; however, pre-treatment with vitamin E can also prevent alcohol-induced vascular injury and pathology in the

brain.[19] (Learn more about free radicals on page 199–201.)

What about humans? Can they benefit from IV magnesium for reversing symptoms of stroke? I interviewed Dan Haley, a former New York assemblyman, on this topic. Dan has spent over a decade researching alternative healing modalities and wrote a book called *Politics in Healing* (2000). When Dan suffered a stroke that paralyzed his entire left side in August 2004, one of his many connections advised him to immediately see a doctor in Washington, D.C., who offers IV magnesium and oxygen for this condition. Dan had already seen some improvement with several acupuncture treatments and could move his left hand, but his doctor had to go to China, so Dan went in the other direction, to Washington. Within ten days of receiving these daily treatments as an outpatient, Dan was walking and had full use of his left arm.[20]

Dr. Bruce Rind is Dan's Washington doctor. He and Dr. Sean Dalton developed the RELOX procedure for stroke, which consists of an intravenous vitamin mineral solution, with a heavy emphasis on magnesium, and the simultaneous application of oxygen by mask. In Dan's case, Dr. Rind added hour-long sessions in a hyperbaric oxygen chamber to further enhance the delivery of oxygen to the brain.

Drs. Dalton and Rind presented their RELOX protocol at the Neuroscience 2005 Conference in Washington, in November. The conference was attended by 30,000 people and honored with a keynote address by the Dalai Lama. In their talk, "Stroke Rehabilitation: An Investigation of Clinical and Neurological Recovery with a Nutrient-Oxygen

Intervention," the doctors pointed out that there has been little research focused on the potential of cost-effective nutriceutical-biologic interventions to improve/restore clinical and neurological function in subacute-chronic stroke patients who are functioning with paralysis and no hope of cure. They told the audience that the RELOX procedure has been administered to a patient population of over 200 who have suffered the aftereffects of stroke from periods ranging from a few days to twenty-plus years.

Their results have been nothing less than miraculous. Patients with mild to moderate impairment experienced "moderate to significant, relatively sustained clinical recovery of cognitive, motor, and sensory functions after three 40-minute treatments with no significant adverse effects." SPECT scans of these patients suggested "cerebral functional volume recovery correlated with CBF (cerebral blood flow) and metabolic increases."

Contrary to most medical opinion, Drs. Rind and Dalton are proving that the area of stroke damage "may represent relatively viable, functionally depressed, albeit potentially salvageable regions for a more extended period following stroke or other cerebral insult than heretofore estimated."

The good doctors know this to be a real possibility because their procedure has helped the majority of patients treated. They remark, "Given the potentially remarkable personal, social, and economic benefits for patients and society, further investigation of the RELOX Procedure's clinical and neurological efficacy, safety, and mechanisms of action is warranted."

Drs. Rind and Dalton plan a pilot study of chronic stroke

patients involving acute-subacute stroke, cerebral palsy, and traumatic brain injured patients. You can find their contact information in the Resources section.

BRAIN SURGERY AND MAGNESIUM

During and after brain surgery, magnesium's many attributes come into play by preventing stroke, keeping calcium from entering damaged cells, and decreasing the incidence of seizure and spasm. These favorable effects have all been proven unequivocally in animal studies, but clinical experience in the neurosurgical operating room also proves its efficacy as lives are being saved. Many surgeons make it standard procedure to administer intravenous magnesium to all their surgical patients before an operation. Dr. Bernard Horn, a general surgeon in California, has given intravenous magnesium sulfate to more than 8,000 patients over a fifteen-year period. Dr. Horn reports that blood pressures as high as 200 over 150 would normalize before surgery.[21]

Intravenous magnesium sulfate also acts as a general anesthetic so that during surgery the dose of other chemical anesthetics can be safely reduced. Using intravenous magnesium also results in lower postoperative pain scores, less pain medication needed in the twenty-four hours after surgery, and less postoperative nausea and vomiting. Magnesium sulfate is therefore a safe and cost-effective addition to such general anesthetics as propofol, remifentanil, and mivacurium.[22]

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM AND BRAIN SURGERY

1. Good neurosurgeons give magnesium to all their surgical patients.

2. Magnesium helps the brain recover from brain surgery.

3. Magnesium can prevent post-surgical strokes or make them less damaging.

Decades of research show that withdrawal of magnesium from cerebral arteries causes them to spasm, whereas elevated magnesium produces relaxation.[23], [24], [25] Animal studies show that when there is normal or elevated magnesium in the brain, the damage caused by stroke is reduced and the neurological deficit is lessened. This is because magnesium blocks calcium from flooding the cells and causing injury. Further research indicates that the area of the brain damaged by stroke contains injured neurons that remain hyperactive for several hours after the stroke has occurred.[26] These cells are frantically struggling to survive and need even more oxygen, glucose, and magnesium than normal. In addition, when these vital nutrients are deficient, those neurons become especially vulnerable to the damaging effects of excitotoxins that rush in to fill the void left by escaping nutrients. Hospitalized patients commonly have low magnesium levels, which means that neurons are even less likely to survive. According to one researcher, a state of severe magnesium deficiency alone is enough for rats to develop widespread injury to their brains, affecting key brain functions.[27]

A study of stroke patients in New York highlights the absolute requirement for magnesium intervention in the ER. Ninety-eight patients admitted to the emergency rooms of three hospitals with a diagnosis of stroke exhibited early and significant deficits in magnesium ions as measured with a sensitive ion-selective electrode. The stroke patients also demonstrated a high calcium-ion-to-magnesium-ion ratio, signs of increased vascular tone, and cerebral vessel spasm.[28]

MAGNESIUM AND SEIZURES

The brain is in a state of constant electrical activity. Brain cells are either stimulating or suppressing activity in a delicate push-and-pull balance. These cells are controlled by switches: some switches are turned on and some are turned off by neurotransmitters. The action of these neurotransmitters could not take place without calcium, magnesium, and zinc, which play various roles in the response of the nerve cells to electrical stimulation.

Brain cells altered by trauma, chemicals, or severe stress can be permanently switched on and fire excessively. Repeated firing in many nerve cells may result in seizures. Magnesium raises the threshold for seizures, reducing the chance of them developing at all. Conversely, experimental studies have shown that low magnesium in the body makes seizures more likely to occur.[29]

Magnesium sulfate for the treatment of seizures and hypertension in pregnancy is safe and effective and universally accepted. Unfortunately, large clinical trials using magnesium for other types of seizures and epilepsy has not been forthcoming. However, oral magnesium is used as an adjunct to antiepileptic medication by many practitioners.

CHAPTER SIX

CHOLESTEROL AND HYPERTENSION

High cholesterol and hypertension are two conditions that plague Americans in epidemic proportions, and they appear to be the initial insults that lead to heart problems over time. But surprisingly, the real story behind both conditions could be a lack of magnesium.

CHOLESTEROL

There are several types of cholesterol with different functions; some of these types we label "good" and some "bad." High-density lipoprotein, HDL, is generally considered to be beneficial to the body; it helps remove cholesterol from blood vessel walls and the blood itself, bringing it to the liver for processing and excretion. Low-density lipoprotein, LDL, is harmful to the body because it carries cholesterol into the bloodstream, promoting the buildup of cholesterol plaque on the arterial walls. Very-low-density lipoproteins, VLDLs, are made into LDLs and therefore are harmful.

All of these cholesterols are normally found in the body. What's *not* normal is the high amounts of oxidized cholesterol (cholesterol abnormally bound with oxygen) that we eat in processed foods, fast foods, and fried foods. In addition, chlorine, fluoride in water, pesticides, and other environmental pollutants can also oxidize cholesterol in the body. It is this oxidized cholesterol that researchers are concerned about when it comes to heart disease.[1]

Regular use of antioxidants such as magnesium, vitamin E, vitamin A, vitamin C, and green tea can lower oxidized cholesterol levels. There is compelling evidence that magnesium therapy reduces cholesterol levels,[2], [3], [4] even when there is a genetic risk factor present for hypercholesterolemia.[5]

Unfortunately, there are no visible physical symptoms of high cholesterol beyond the associated signs of a bad diet, sedentary lifestyle, smoking, alcohol intake, and stress. You have to find it on a blood test. A poor diet with a high

intake of saturated and polyunsaturated fats, hydrogenated oils, fried foods, meat, sugar, coffee, and alcohol will elevate cholesterol levels, especially when a person lacks fiber from whole grains and vegetables. Add a sedentary lifestyle with weight gain, and cholesterol increases.

The very diet that promotes elevated cholesterol also causes magnesium deficiency. Unfortunately, many doctors do not have the time or inclination to educate patients about correct eating habits that could reduce their cholesterol; instead they rely on medication to treat the problem. To be fair, many patients don't have the inclination to comply even if their doctor recommends a change in diet, exercise, and weight loss. Adding magnesium supplementation to lifestyle changes, however, gives patients more dramatic improvement, making compliance easier.

Many of us have been conditioned to believe that elevated cholesterol is the only cause of heart disease; that is why marketers have been so successful in getting us to replace saturated fat such as butter with hydrogenated vegetable oils. Yet epidemiologists and dental anthropologists proved long ago that various world cultures that ate high-cholesterol diets for thousands of years (including meat, lard, cream, butter, and eggs) suffered very little, if any, heart disease.[6] Almost all the long-lived, healthy communities where degenerative disease and heart disease were unknown included significant amounts of natural, unprocessed meat or dairy in their diets. And it is also clear that once a country is exposed to refined and processed food, or "altered" meat

and “altered” dairy, health declines in a number of ways.[7], [8], [9] Hydrogenated oils are unsaturated oils and for that reason were thought to be healthier than saturated fats such as butter. But the processing of liquid vegetable oil by heat, pressure, and chemicals to change it into a solid fat creates an unhealthy synthetic product called a trans fatty acid (as opposed to the natural cis fatty acid).

A major disadvantage of low-fat products is that they often contain extra sugar in order to capture the taste buds. Even worse is aspartame, a synthetic sweetener with a daunting list of side effects to its name. To maintain your health, avoid both.

Only in the late 1990s did research show that these highly refined hydrogenated oils themselves promote atherosclerotic plaque much more than butter. In fact, some scientists say that the rise of heart attacks, and heart disease in general, can be traced back to the late 1930s, when hydrogenated oils were first introduced. We now know that trans fatty acids cause arterial damage as well as cancer. Be sure to read labels to avoid this substance.

WHAT CHOLESTEROL DOES

Not just adults but every schoolchild has been conditioned to believe that cholesterol is the bad guy in heart disease. But did you know that without cholesterol we wouldn't be able to have sex, couldn't procreate, and would become extinct? That's simply because sex hormones and stress hormones are made from cholesterol. It's also necessary to create cell membranes and coat nerves with a protective fatty insulation that makes up about 60–80 percent of our brain tissue. Cholesterol is also essential for proper food digestion and fat absorption because it produces bile salts. Moreover, if you didn't have cholesterol, your bones would turn to mush because you couldn't make vitamin D from sunlight and wouldn't be able to absorb calcium.

If cholesterol is so crucial to life, why are we trying so desperately to get rid of it? In fact, our body thinks cholesterol is so important that the liver makes about 1,000 mg of cholesterol a day; if we try to lower our cholesterol too much with drugs, the liver merely gears up production. Normally, the liver produces about 85 percent of the cholesterol measured on a blood test. The other 15 percent comes from our diet.

WHEN CHOLESTEROL BECAME THE BAD GUY

In 1913, two Russian researchers fed large amounts of cholesterol to a group of hungry rabbits. When they saw yellow gunk clogging the rabbits' arteries, they leapt to the conclusion that cholesterol must be responsible for coronary artery disease.[10]

Robert Ford, as long ago as 1969, called the cholesterol theory of heart disease a tragic blunder.[11] In a book called *Stale Food vs. Fresh Food*, he gave us some important information about the Russian experiment that had been overlooked. He wrote, "Their finding was one of those unfortunate half-truths which only served to mislead." In his commonsense way of looking at the cholesterol theory of heart disease, Ford said, "It is absurd to say that something we are largely made of would be harmful for us to eat."

Ford explained that dietary cholesterol is harmful only if it is stale or rancid. When he read the original article by the Russians he was amazed to discover that they had fed their rabbits "pure crystalline cholesterol dissolved in vegetable oil" to produce the cholesterol buildup in arteries. They didn't stop to think that crystalline cholesterol is not something the body can use but is "an unnatural stale substance now known as oxycholesterol, which is not found in fresh food or in the healthy human body." Ford said the cholesterol theory is untrue and has served to deceive us by delaying discovery of the true causes and cures.

Udo Erasmus wrote an enlightening book about fats and oils called *Fats That Heal, Fats That Kill*. From his decades-long research he concludes, "The cholesterol scare is big

business for doctors, laboratories, and drug companies. It is also a powerful marketing gimmick for vegetable oil and margarine manufacturers. In the end, cholesterol will be exonerated from its role as primary villain in cardiovascular disease. The accusing finger points at 'experts' who concocted the cholesterol theory to drum up business by spreading fear."[12]

THE DRUG TREATMENT OF CHOLESTEROL

Statins are a group of powerful drugs that block a specific enzyme in the liver that helps make cholesterol. When that enzyme is blocked, cholesterol levels are lowered. That enzyme, however, does much more in the body than just make cholesterol, so when it is suppressed by statins there are far-ranging consequences.

One major side effect that medicine acknowledges is elevated liver enzymes. Because statins work on liver enzymes, they can disrupt liver function. If you take statins, you must have regular blood tests to look for liver damage; stopping statins if your liver is damaged usually reverses the problem.

Another acknowledged side effect, statin myopathy, is an iatrogenic (doctor-induced) condition that damages muscles and is entirely related to statin intake. Statins cause a kind of muscle cell destruction called rhabdomyolysis, leading to muscle pain and tenderness. Myoglobin is a muscle protein that is released into the bloodstream and can be measured as a sign of statin myopathy. Interestingly, about 40 percent of the magnesium in the body is found in muscles, and magnesium is the mineral component of myosin (a large protein that forms skeletal muscle). So when muscle is destroyed, magnesium is lost from its storage site.

Unfortunately, several statins contain toxic fluoride molecules that irreversibly bind magnesium, contributing to the side effect of muscle pain. Another side effect is the inhibition of coenzyme Q_{10} production. CoQ_{10} is a fat-soluble antioxidant found in large amounts in the

mitochondria. Mitochondria are the principle powerhouses of cells, producing energy for the whole body. Lowered levels of coenzyme Q_{10} along with magnesium deficiency contribute to muscle damage called myopathy and also produce neuropathy (nerve damage), memory decline, including global amnesia, and cardiomyopathy (destruction of heart muscle). Many doctors prescribe high doses of expensive coenzyme Q_{10} supplements if you are on statin drugs. But you can get enough CoQ_{10} from fish, beef, pork, chicken heart, chicken liver, parsley, and perilla. If you also take magnesium, your CoQ_{10} levels should normalize. However, what might work even better is to use magnesium as your first line of treatment for elevated cholesterol so you don't have to touch statin drugs at all.

MAGNESIUM ACTS LIKE A NATURAL STATIN

A well-known magnesium proponent, Mildred Seeling, M.D., just before she died in 2004, wrote a fascinating paper with Andrea Rosanoff, Ph.D., showing that magnesium acts by the same mechanisms as statin drugs to lower cholesterol.[13]

Every metabolic activity in the body depends on enzymes. Making cholesterol, for example, requires a specific enzyme called HMG-CoA reductase. As it turns out, magnesium slows down this enzymatic reaction when it is present in sufficient quantities. HMG-CoA reductase is the same enzyme that statin drugs target and inhibit. The mechanisms are nearly the same; however, magnesium is the natural way that the body has evolved to control cholesterol when it reaches a certain level, whereas statin drugs are used to destroy the whole process. This means that if sufficient magnesium is present in the body, cholesterol will be limited to its necessary functions—the production of hormones and the maintenance of membranes—and will not be produced in excess.

It's only in our present-day circumstances of magnesium-deficient soil, little magnesium in processed foods, and excessive intake of calcium and calcium-rich foods without supplementation of magnesium that cholesterol has become elevated in the population. If there is not enough magnesium to limit the activity of the cholesterol-converting enzyme, we are bound to make more cholesterol than is needed.

The magnesium/cholesterol story gets even better. Magnesium is responsible for several other lipid-altering

functions that are not even shared by statin drugs. Magnesium is necessary for the activity of an enzyme that lowers LDL, the "bad" cholesterol; it also lowers triglycerides and raises the "good" cholesterol, HDL. Another magnesium-dependent enzyme converts omega-3 and omega-6 essential fatty acids into prostaglandins, which are necessary for heart and overall health.

Seelig and Rosanoff conclude their paper by saying that it is well accepted that magnesium is a natural calcium channel blocker, and now we know it also acts like a natural statin. In their book *The Magnesium Factor*, Seelig and Rosanoff reported that eighteen human studies verified that magnesium supplements can have an extremely beneficial effect on lipids. In these studies, total cholesterol levels were reduced by 6 to 23 percent; LDL (bad) cholesterol were lowered by 10 to 18 percent; tryglycerides fell by 10 to 42 percent; and HDL (good) cholesterol rose by 4 to 11 percent. Furthermore, the studies showed that low magnesium levels are associated with higher levels of "bad" cholesterol and and high magnesium levels indicate an increase in "good" cholesterol.

NORMAL LIPID VALUES

Cholesterol: 180–220 mg/dl

HDL cholesterol: greater than 45 mg/dl

LDL cholesterol: less than 130 mg/dl

VLDL cholesterol: less than 35 mg/dl

Total-cholesterol-to-HDL ratio: in men the optimal ratio is less than 3.43 (average 4.97); in women the optimal ratio is less than 3.27 (average 4.44)

THE LINK BETWEEN OXIDIZED CHOLESTEROL AND HOMOCYSTEINE

When Russian researchers showed that oxidized cholesterol causes blocked arteries, instead of learning from that message that oxidized cholesterol might be the problem, everyone assumed all cholesterol was bad. One process that produces oxidized cholesterol in the body is described by Dr. Kilmer McCully. He was the first researcher, back in 1969, to identify a condition of increased levels of an amino acid, homocysteine, in the urine of patients with heart disease, which could be reversed with certain nutrients.[14], [15]

Homocysteine is a normal by-product of protein digestion, which in elevated amounts causes the oxidization of cholesterol—and it is oxidized cholesterol that damages blood vessels. For certain individuals who lack specific enzymes for protein digestion, homocysteine can become a real problem.

A healthy level of homocysteine is below 12 μmol/L. Homocysteine levels greater than 12 μmol/L are considered high, and when homocysteine is elevated in the cell, magnesium measures low. Twenty to 40 percent of the general population have elevated levels of homocysteine. Individuals with high levels have almost four times the risk of suffering a heart attack compared to people with normal levels.[16] Elevated homocysteine is high on the list of risk factors for heart disease and serves as an even stronger marker than high cholesterol for heart disease and blood clotting disorders.[17], [18]

The more relevant marker may be low magnesium since

the major enzymes involved in homocysteine metabolism are magnesium-dependent.[19] McCully blames too much protein in the diet for elevated homocysteine. However, when magnesium, vitamin B_6, vitamin B_{12}, and folic acid are deficient, the body is not able to properly digest protein. The B vitamins were readily available in the typical diet a hundred years ago; now that they're absent from the diet, homocysteine becomes elevated and heart disease results.

When these metabolic nutrients are reintroduced through diet or supplements, the high homocysteine levels are reversed and the symptoms of heart disease diminish. Ongoing research confirms that B_6, B_{12}, and folic acid together with magnesium are necessary to prevent blood vessel damage induced by high levels of homocysteine in the blood.[20] In short, the successful treatment of homocysteinuria relies on dietary changes that include B vitamins and magnesium.[21], [22], [23] However, magnesium is often left out of the prescription for homocysteinuria in favor of the B vitamins—a common but serious error on the part of conventional medicine.

It must be remembered that high homocysteine is also a marker for all causes of mortality, which underscores that a deficiency in essential nutrients has a far-reaching effect on the body far beyond heart disease.[24]

HYPERTENSION

Hypertension is an elevation of blood pressure suffered by more than 50 million Americans. Most often, hypertension is diagnosed during a routine physical exam. It presents no distinguishing signs or symptoms unless the condition is very advanced, in which case headache, dizziness, and blurred vision can occur.

Normal blood pressure is a range: 100–140 over 60–90. Systolic pressure is the first number and relates to the pump pressure that the heart muscle creates to push blood into the arteries. Diastolic pressure is the second number and is the pressure that the arteries maintain when the heart is relaxed, between heartbeats, to keep the arteries open.

Hypertension is either primary or secondary. Primary hypertension is said to have no single cause and occurs in 90 percent of all hypertensive patients. Secondary hypertension is secondary to another disease. Causes of primary hypertension include high cholesterol, family history, obesity, diet, smoking, stress, and excessive salt intake—but one major cause that is overlooked is magnesium deficiency.

The necessity to keep blood pressure as low as possible may be another myth of modern medicine, just like cholesterol. In the past decade the value for high blood pressure has been lowered to the point that a majority of Americans fall in what's now called a prehypertensive category. When people are told they are prehypertensive, they don't hear the "pre-" part they just hear "hypertensive," and it scares them—sometimes enough to elevate their blood pressure, much like in what's called

white-coat syndrome. This syndrome has your heart beating faster and your blood pressure rising because you are afraid your doctor will tell you that your blood pressure is elevated. Normal at home but high in the doctor's office is white-coat syndrome, not hypertension.

Certainly, high blood pressure is to be avoided, but these new values for normal blood pressure make it appear that almost everyone is susceptible to high blood pressure and should be on drugs. With the elderly and their slightly rigid blood vessels, a somewhat elevated blood pressure may be necessary to keep blood pumping to their head and extremities—and attempting to achieve a lower blood pressure in such individuals may perhaps cause dizziness and falls that could otherwise be prevented. A much more expedient solution is weight loss, exercise, stress reduction, and magnesium to prevent hypertension.

DRUGS FOR BLOOD PRESSURE

Diuretics are the first drugs on the recipe list for high blood pressure. These drugs help flush water from the body according to the theory that if there is less salt and water in your bloodstream, then there is less pressure on your blood vessels. But how is a doctor supposed to know if a patient has too much water in the bloodstream without doing complicated tests? And if you get rid of too much water, doesn't that make you dehydrated, thicken your blood, and make you susceptible to clotting-related conditions such as strokes and deep-vein thromboses?

Dr. Batmanghelidj, in his book *Your Body's Many Cries for Water*, says that dehydration *causes* high blood

pressure.[25] When the body is even slightly dehydrated, it attempts to hold on to whatever water it can by constricting blood vessels throughout the body. You sweat less and lose less moisture when you breathe—but constricted blood vessels mean increased blood pressure.

Dehydration is very common; most people don't drink enough water anyway, so why squeeze out more with a diuretic? When patients are prescribed diuretics, they are warned that the most common side effect is a deficiency of potassium, which spills out in the urine. To prevent it, they are advised to eat bananas and oranges or take potassium pills. What they are not told is that magnesium is drained out along with potassium. Recall that magnesium deficiency leads to blood vessels that are less relaxed and more susceptible to spasm and tension, a precursor to hypertension; thus the very treatment for hypertension worsens the problem.[26] (Ironically, replacing potassium doesn't help patients who are also magnesium-deficient, because the body is unable to deliver potassium to the cells without sufficient magnesium. Even the so-called potassium-sparing diuretics still commonly deplete other minerals, including magnesium.)[27] The common side effects of diuretics include weakness, muscle cramps, joint pain, and irregular heartbeat. They are also symptoms of magnesium deficiency. Proper testing for Magnesium RBC should be a routine procedure when you are taking diuretics, but it currently is not.

DIURETICS DRY OUT THE BRAIN

A journal case study reported that an elderly woman's serum magnesium level became depleted due to a diuretic she was taking for hypertension.[28] She was admitted to the hospital with severe weakness and developed an overt psychosis with paranoid delusions. Fortunately, her magnesium deficiency was identified, and following large intravenous doses of magnesium, her symptoms disappeared within twenty-four hours. However, she was unable to discontinue magnesium therapy without a recurrence of her symptoms as long as she was taking the diuretic. No other abnormalities were found to explain her condition. People who are prescribed diuretics should check with their doctor about taking at least 600 mg a day of supplemental magnesium in divided doses. In that way, many of the side effects of diuretics can be avoided.

THE BLOOD PRESSURE RECIPE

If blood pressure is not controlled with diuretics, the next choice may be ACE inhibitors, calcium channel blockers, anti-adrenergic drugs, or vasodilators. The treatment of high blood pressure by an internist friend provides a good example of "recipe medicine." I arrived early for an interview with my doctor friend and he invited me to sit in on an appointment with a very stressed, overweight newspaper reporter who was suffering from intractable high blood pressure in spite of being on a total of four different blood pressure medications. The patient said he was becoming depressed and was very concerned about his blood pressure. I recognized that the medications he was on could cause depression, as could the stress of having a case

of high blood pressure that does not respond to treatment. But I also asked about impotence, suspecting this side effect of his drugs as a possible cause of his depression. He said he had been suffering impotence since going on the medications but had attributed it to stress.

As I noted earlier, the patient was overweight. When I asked about diet, the doctor admitted that he hadn't offered specific diet advice to the patient but did tell him to try to lose weight. I also mentioned the usefulness of magnesium as a mineral that excels as a natural antihypertensive, muscle relaxant, antianxiety remedy, and sleep aid. The doctor said that if the four different types of antihypertensive drugs don't help a patient, he will add magnesium, and it always works. Only professional courtesy kept me from shouting, "Why not prescribe the magnesium first, before all the other drugs with their nasty side effects?"

Fortunately, a growing number of internists and cardiologists know that magnesium is a physiological necessity and a pharmacological treasure to use before drug intervention. They call magnesium the ideal drug: it is safe, cheap, and simple to use, with a wide therapeutic range, a short half-life, and little or no tendency toward drug interactions.[29]

WEIGHT LOSS DROPS BLOOD PRESSURE

Long before drugs are introduced, diet should be the first treatment of choice for hypertension. Research shows a direct relationship between the amount of magnesium in

the diet and the ability to avoid high blood pressure.[30] The Alturas first demonstrated that diets deficient in magnesium will produce hypertension in experimental animals.[31] Diet may lower the blood pressure successfully due to a combination of weight loss and increased intake of the vitamin and mineral cofactors necessary in blood pressure control. For example, increased levels of minerals such as potassium and magnesium in the diet have a suppressive effect on calcium-regulating hormones, which influence blood pressure.[32] The arterial blood pressure appears to go up as the levels of magnesium ions and serum magnesium go down.[33]

Weight loss is given only a passing mention in most clinical textbooks on blood pressure. The authors in these texts admit that if you can get a person to lose weight, then his or her blood pressure will usually go down. Every study that's been done on this subject reports this association. However, most doctors say that because they have little success with helping their patients lose weight, they often offer medications as the first line of treatment. Doctors have two strikes against them when it comes to weight loss: they receive no training in weight loss management in medical school, and health insurance does not pay for nutritional counseling or prevention of disease —it pays only when there is a disease code.

Note: Some forms of severe high blood pressure are hereditary or due to kidney disease and do require medication. Also, if the arteries in the body are damaged from long-term atherosclerotic injury and scarring, unfortunately they may no longer respond to magnesium

and you may require medications to keep your blood pressure under control. And if you have been cautioned to not take magnesium if you have kidney disease, please read the section called “Kidney Disease and Magnesium Misinformation” in the Introduction.

For information on magnesium supplements for hypertension, see “Supplements for Heart Disease” on this page.

CHAPTER SEVEN

MAGNESIUM AND HEART DISEASE

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM AND HEART DISEASE

1. Magnesium prevents muscle spasms of the heart blood vessels, which can lead to heart attack.
2. Magnesium prevents muscle spasms of the peripheral blood vessels, which can lead to high blood pressure.
3. Magnesium prevents calcium buildup in cholesterol plaque in arteries, which leads to clogged arteries.

Annette was tired of people's shocked reaction when they learned that she was recovering from a heart attack. She knew that the common image of heart disease was that it afflicted aggressive, overweight men who smoked and ate too much. Annette, on the other hand, was slim, reserved, and a vegetarian who ate a low-fat diet. She chuckled when friends tried to tell her about the Dr. Dean Ornish

vegetarian diet for reversing heart disease, because she'd lived according to that diet.

She was only fifty-six, a nonsmoker, with exemplary cholesterol levels, but she did have elevated blood pressure, her only risk factor. And, as she was told by her doctor, because of her blood pressure, she had had a mild heart attack. Now she suffered from daily palpitations and was on several medications that seemed to drain her energy more with every passing day. She was also simply too afraid to exert herself for fear of bringing on another heart attack.

Annette was becoming an invalid, and at her next appointment her cardiologist was shocked at her worn-out appearance. He decided to run some blood tests and was urged by a student doctor to order a Magnesium RBC test. The results of that test were so low that his nurse immediately called Annette to come in, saying the doctor had found something that would help her feel better. Annette was recommended a Magnesium citrate preparation that she mixed with water that began to work within twenty-four hours. She was amazed that her muscle aches, insomnia, palpitations, and fatigue all but disappeared. She was even able to cut back on her other medications. Her doctor vowed to test all his patients' magnesium red blood cell levels from then on, and wondered aloud if it had been low magnesium in the first place that had led to Annette's heart attack.

AN IMPORTANT REMINDER ABOUT TAKING MAGNESIUM WITH PRESCRIPTION DRUGS

You may experience a decreased need for your drugs as magnesium deficiency is corrected or as magnesium treats your symptoms or reverses your condition. In other words, the symptoms for which the drug was prescribed may clear up due to the magnesium, making the drug unnecessary or toxic and causing new symptoms. Patients and doctors should be on the alert for a shift in symptoms. Be sure to work with your doctor to lower your medication doses safely.

A 2003 study gives doctors all the evidence they need to include magnesium in their protocol for women suffering heart disease. The findings from this study show that "dietary magnesium depletion can be induced in otherwise healthy women; it results in increased energy needs and adversely affects cardiovascular function during submaximal work."[1]

As we will learn in Chapter 10, obstetricians are quite familiar with the use of magnesium for hypertension in women about to deliver. Unfortunately, they aren't talking to cardiologists or even to family doctors about the importance of magnesium in treating general hypertension, one of the main risk factors for heart disease, or using magnesium to prevent heart problems.

Heart disease is the number one killer of both American women and men, accounting for half of all U.S. deaths (52.3 percent of the total deaths occurring in women, compared to 47.7 percent in men). According to the American Heart Association, every thirty-three seconds someone in the United States dies of cardiovascular disease; that's approaching 1 million deaths annually. Hypertension occurs in 50 million Americans and accounts for an estimated 29.3 million office visits a year to conventional medical doctors.[2] Prescriptions for anti-hypertensive drugs are given at most of these appointments, even though magnesium has been used successfully for over half a century by medical doctors, osteopaths, and naturopathic doctors.[3], [4]

THE SLIPPERY ROAD TO HEART ATTACK

STEP ONE: LOSS OF ARTERIAL ELASTICITY

The coronary arteries bringing oxygen-filled blood from inside the heart through the aorta to the heart muscle are very, very small, only about 3 mm across (a nickel is 2 mm thick). It doesn't take much to plug them up with a tiny blood clot or to cause them to collapse when in spasm. Magnesium prevents blood clot formation and artery spasm. These blood vessels get even smaller as they split into two, then four, then eight, and so on as they descend toward the bottom of the heart; some of the tiniest

capillaries are only the width of a red blood cell. Each of these splits is called a bifurcation. According to cardiologists, about 85 percent of sclerotic plaques initially form near bifurcations. It is widely believed that the development of these plaques is a response to injury. This means that something, such as an infection, may be damaging the arteries, initiating the buildup of fat and calcium around the inflammation.

Endothelial cells are a single layer of specialized cells that form the inside membrane of an artery. The subendothelial layer (the next layer in) is a very thin connective tissue that contains elastin. As its name implies, this is the layer responsible for providing much of the elasticity in your arteries. It is important to note that your body requires magnesium to maintain healthy elastin. One of the earliest signs of magnesium deficiency is degeneration of elastin in the subendothelium.

Smooth muscle cells are the next layer. Smooth muscle cells provide integrity and control the dilation of the arterial cavity, triggered by the calcium/magnesium ratio in the body. Calcium causes contraction and magnesium causes relaxation, which together control the blood pressure and flow in the artery. A final messenger for the dilation response is nitric oxide, which is dependent on magnesium. Animals on low-magnesium diets lose the elasticity of their arterial system. Coronary arteries require even more elasticity than other arteries because they must stretch and flex as the heart expands and contracts. Loss of elasticity results in inflammation of the

endothelial and subendothelial layers at the points that are most mechanically challenged by stretching: the bifurcations. Imagine a small rubber-band-like tube shaped like a Y. In your mind's eye grasp the two legs of the Y in one hand. With your other hand, grip the single leg. Begin pulling them apart just as though they were stretching on the surface of the heart. Stretch it as far as you can. Where is the shape weakest? If we left the rubber tube out in the sun for a week or so, what would happen if you slowly stretched it again? Where might you expect the first crack to appear? Most of the time it would happen at or near where one tube becomes two—at the bifurcation. If your artery loses elasticity, it makes sense that the problem might show up at or near the bifurcation.

STEP TWO: THE INFLAMMATORY RESPONSE

Inflammation begins with injury of the artery wall, leading to white blood cells and cholesterol hovering around trying to heal the damage. At this stage in the process, if there is too much calcium and not enough magnesium in the bloodstream, excess calcium precipitates around the area of inflammation in the artery wall. The area becomes rigid and interferes with blood flow.

STEP THREE: HEART ATTACK

Over time, the above steps weaken and plug the coronary arteries and slowly destroy small areas of the heart muscle. The final result is severe chest pain, damage to a

larger portion of heart muscle, and heart attack.[5]

Some of the first evidence for the use of magnesium against heart disease came from epidemiological studies in Wales, Taiwan, Sweden, Finland, and Japan showing that death rates from coronary heart disease are higher in communities with magnesium-deficient water and magnesium-deficient diets.[6] Areas where calcium in the water is much higher than magnesium or where dietary intake of calcium is higher than magnesium showed even more coronary heart disease. A U.S. study done over a seven-year period followed 14,000 men and women and concluded that low magnesium in the diet may contribute to coronary atherosclerosis and acute heart attack.[7]

The Centers for Disease Control and Prevention in Atlanta followed 12,000 people for nineteen years, at the end of which 4,282 people had died, 1,005 from heart disease. Risk of dying from heart disease was highest in those with magnesium deficiency. Researchers made a conservative estimate that 11 percent of the half million deaths related to heart disease in 1993 could have been directly related to magnesium deficiency.[8] If more accurate measurements for magnesium deficiency were used, such as Ionized agnesium Testing, we would find the numbers to be even higher and the need for magnesium even greater.

The evidence has been mounting for decades that magnesium plays a crucial role in the prevention of both atherosclerosis and arteriosclerosis.[9], [10] It maintains the

elasticity of the artery wall, dilates blood vessels, prevents calcium deposits, and is necessary for the maintenance of healthy muscles, including the heart muscle itself. For all these reasons, magnesium is critical to the maintenance of a healthy heart.[11] One of the pivotal metabolic chemicals in the body is nitric oxide (NO). It is a very simple compound made from nitrogen and oxygen, but it packs a powerful punch. Nitric oxide controls vasodilation, but this activity is under the direction of magnesium.[12]

C-REACTIVE PROTEIN

A December 2005 study confirms that C-reactive protein (CRP) has emerged as one of the most powerful predictors of heart disease.[13] In time, as more research is done, CRP will probably supplant cholesterol as the most significant predictor. Why is this important? Because CRP is an indicator of inflammation—and as previously noted, it's the injury and inflammation of heart blood vessels that underlie heart disease. The 2005 study also examines uric acid and finds that this product of protein breakdown, which is associated with hypertension, inflammation, and heart disease, also damages blood vessel walls. This action is mediated by nitric oxide and causes elevated CRP. These findings heighten the important role of magnesium in the process. Sufficient magnesium can hinder the pathology at every stage, whereas anti-inflammatory prescription drugs are ineffective and can carry dangerous side effects. An optimal level of CRP is less than 6 mg/l.

A U.S. study, reported in the July 2006 issue of the journal *Nutrition Research*, found that a daily magnesium supplement could reduce the levels of inflammation, as measured by C-reactive protein, that could lead to heart disease in people with low dietary intake of the mineral. This is very encouraging news in the fight against the single largest killer in the United States. It's also encouraging that researchers are investigating magnesium supplementation and not just dietary magnesium. In this study of over 10,000 people, only 21 percent were getting the RDA for magnesium in their diet. Another 26 percent were taking magnesium supplements, and it was that group

that exhibited a lower C-reactive protein than the magnesium-deficient group.

ATHEROSCLEROSIS

It is easy to confuse the terms *arteriosclerosis* and *atherosclerosis:* in fact, many people use them interchangeably. *Arteriosclerosis* is the overall term for scarring of the arteries. *Atherosclerosis* is scarring or thickening specifically due to fatty plaques. When the diameter of an artery is already narrowed by fat deposits, a blood clot or an arterial spasm can be the final straw that results in angina, heart attack, or stroke. Complications of this preventable condition of atherosclerosis cause over a third of all deaths in the United States.

SUPPLEMENT AND DRUG INTERACTIONS IN HEART DISEASE

1. Calcium interacts with verapamil (Calan, Isoptin, Verelan). Verapamil is a calcium channel blocker, and calcium interferes with the hypotensive effect of this drug. Avoid calcium until your doctor weans you off this drug.

2. Vitamin B_1 (thiamine) interacts with furosemide (Lasix). Lasix causes increased urinary excretion of B_1, so supplements of this vitamin may be necessary.

3. Vitamin B_6 interacts with hydralazine (Alazine, Apresazide, Apresoline, Unipres). Hydralazine causes increased excretion of vitamin B_6;

supplements of the nutrient may be necessary.

4. Calcium, magnesium, and potassium interact with furosemide (Lasix), which causes urinary excretion of these minerals. Monitor levels of these nutrients and replace as necessary.

5. Grapefruit juice makes felodipine (Plendil) and nifedipine (Adalat, Procardia) more powerful; it increases the action of these drugs by temporarily blocking the enzyme that clears them from the body. You may have to avoid grapefruit juice while on these medications.

6. Magnesium, calcium, potassium, and sodium interact with thiazide diuretics such as chlorothiazide (Diuril, Diachlor) and hydrochlorothiazide (Aldoril, Hydrodiuril).
Thiazides work by increasing urinary excretion of sodium, which presumably lowers blood pressure. However, significant amounts of calcium, potassium, and magnesium are also excreted. Magnesium at 600 mg per day may have to be increased to 900 mg if you are on thiazide diuretics or digitalis because both drugs cause excretion of magnesium. Your doctor should do a Magnesium RBC test or EXATest to determine your needs. (See Chapter 16 for more on magnesium testing.)

7. Potassium and magnesium deficiencies lead to arrhythmias in patients on digoxin (Lanoxin).

8. Small increases in plasma calcium increase

digoxin (Lanoxin) toxicity. Some specialists advise avoiding high-calcium foods for two hours before and after taking this drug.

9. Calcium should be supplemented due to decreased absorption of vitamin D with patients using the cholesterol-lowering drugs colestipol (Colestid) or cholestyramine (Questran).
10. Colestipol (Colestid) interferes with absorption of iron, folate, and vitamins A, D, E, and K.
11. Cholestyramine (Questran) interferes with absorption of iron, folate, and vitamins A, D, E, and K.
12. Heparin interferes with renal hydroxylation of vitamin D. This could lead to osteopenia; your doctor may need to check your vitamin D status with a 25-hydroxy vitamin D test, also called 25(O++)D.
13. Vitamin K inactivates warfarin (Coumadin); warfarin interferes with vitamin K synthesis.[14]

Researchers have identified various causes of damage to the inner wall of arteries, including homocysteine, an amino acid discussed earlier that creates oxidized cholesterol; infection by an organism called chlamydia; distorted blood flow around the mound of fat; free radicals; high blood sugar; high blood pressure; and lack of oxygen. As described previously, the damaged tissue of the artery wall initiates an inflammatory process. The inflammation then attracts “bad” cholesterol (LDL) and calcium, which build

up into a solid scar. Magnesium has a role to play in reducing homocysteine levels, preventing free radicals, balancing blood sugar, and reducing high blood pressure.

ANGINA

Angina describes an episodic pain in the region of the chest and/or down the left arm due to lack of oxygen to the heart muscle and a buildup of carbon dioxide and other metabolites. Usually the pain, which can be a mild ache, pressure, or fullness, or a crushing pain, comes on with exercise (especially in the cold), emotional stress, a heavy meal, or even a vivid dream, and is relieved (usually within five minutes) by rest and nitroglycerine.

The lack of sufficient blood flow carrying life-giving oxygen and nutrients can be due to blocked coronary arteries or spasms in these tiny vessels. Angina is labeled "unstable" when symptoms become more severe; unstable angina implies a greater risk for heart attack. Another type of angina is called Prinzmetal's, which is angina that occurs at rest, rather than following some sort of physical stress. James B. Pierce, Ph.D., believes he has identified the cause of Prinzmetal's, which occurs most commonly at two specific times in the day, early morning and late afternoon, coincidentally when magnesium levels are at their lowest.[15] Dr. Pierce estimates that up to 50 percent of sudden heart attacks may be due to magnesium deficiency. He found that magnesium worked better than nitroglycerine for his own stress-induced chest pains. In fact, Dr. Pierce could predict that he would get chest pain after a stressful day, a long drive, or an emotional upset and would increase his intake of magnesium to forestall symptoms.

Risk factors for angina include magnesium deficiency, smoking, diabetes mellitus, hyperlipidemia, type A

personality, sedentary lifestyle, poor diet, and family history of coronary artery disease. Diagnosis of angina, to differentiate it from myocardial infarction and unstable angina, includes an EKG (electrocardiogram) taken during an angina attack; an exercise tolerance test, which is an EKG taken while on a treadmill; and a coronary angiogram (an X-ray view of dye in the coronary arteries) to assess whether the coronary arteries are open or blocked.

Once angina is diagnosed, the recommendations are universally known: stop smoking, lose weight, get blood pressure under control (with or without drugs), and in extreme cases of arterial blockages, undergo bypass surgery to circumvent blocked arteries. The best treatment for angina, however, is prevention. By eliminating sugar, alcohol, and junk food from your diet you help prevent heart disease, because these foods are lacking in magnesium and serve only to create magnesium deficiency. When you eat a more balanced, non-processed-food diet, you have a better chance of increasing your magnesium intake. With magnesium and other heart-healthy supplements, a healthy diet, and an exercise regimen, you have a fighting chance of avoiding this epidemic. See this page for a list of supplements to cover all aspects of heart disease.

HEART ATTACKS

Myocardial infarction (MI), or heart attack, causes permanent damage to the heart muscle and requires immediate hospitalization. MI is the result of coronary artery disease due to atherosclerosis or due to spasms caused or aggravated by magnesium deficiency. The artery may be damaged gradually by plaque, become blocked by a blood clot, or both, and suddenly go into spasm; either of these processes can be accelerated by excessive emotion. The calcified atherosclerotic plaque, the blood clot, and the arterial spasm all can be caused or worsened by magnesium deficiency.

Laboratory findings distinguish a heart attack from an episode of angina on the basis of heart muscle damage and certain heart enzyme levels that become elevated several hours after a heart attack and remain elevated for several days. The immediate treatment for an acute heart attack usually includes anticoagulant drugs in an intravenous drip. Intravenous magnesium given as soon as possible after a heart attack, however, may provide the best protection for the heart. Oral magnesium treatment also inhibits blood clots in patients with coronary artery disease whether the patient is on aspirin therapy or not.[16] As more doctors read the considerable research on magnesium they are incorporating magnesium into their intravenous and oral protocols for heart patients.

Magnesium has been studied for its effects on the heart since the 1930s and used by injection for the treatment of heart conditions since the 1940s.[17], [18] Magnesium's lifesaving effects have been confirmed and reconfirmed in

many clinics and laboratories. For example, in an analysis of seven major clinical studies, researchers concluded that magnesium (in doses of 5–10 g by intravenous injection) reduced the odds of death by an astounding 55 percent in acute MI.[19], [20] Over the past decade, several large clinical trials using magnesium have shown its beneficial effects: if intravenous magnesium is given (1) before any other drugs and (2) immediately after onset of a heart attack, the incidence of high blood pressure, congestive heart failure, arrhythmia, or a subsequent heart attack is vastly reduced. One such study, called LIMIT-2, provided powerful evidence that early magnesium administration protects the heart muscle, prevents arrhythmia, and improves long-term survival.[21], [22], [23] Magnesium might improve the aftermath of acute heart attack by preventing rhythm problems; improving blood flow to the heart by dilating blood vessels; protecting the damaged heart muscle against calcium overload; improving heart muscle function; breaking down any blood clots blocking the arteries; and reducing free radical damage. Magnesium may also help the heart drug digoxin to be more effective in the treatment of cardiac arrhythmia;[24] without enough magnesium, digoxin can become toxic.[25]

The suggested criteria for magnesium intervention were not followed in a very large trial called ISIS-4, and the outcome did not show the same results as the LIMIT trial.[26] In the ISIS trial, magnesium was given many hours after the onset of symptoms and after blood-clotting had begun and after blood-clotting drugs had been administered. The two trials were as dissimilar as apples and oranges, yet the

debate over magnesium's efficacy still rages. Since the LIMIT and ISIS studies, several smaller trials have shown even greater recovery from heart attacks using intravenous magnesium, including a trial of 200 people with a 74 percent lower death rate.[27]

Dr. Michael Shechter is a brilliant young magnesium researcher who in his numerous recent clinical trials has proven the benefits of magnesium in treating heart disease. His clinical trials begun in 2000 and continued every year since maintain that magnesium is a viable and necessary treatment for people with heart disease in spite of the ISIS trial and another trial called MAGIC suggesting that it does not.[28], [29], [30], [31], [32], [33]

Pharmaceutical companies, who want to promote their own drug therapies, cite the ISIS trial as proof that magnesium sulfate doesn't work; supporters of magnesium cite the LIMIT trial as proof that it does. Your doctor may be influenced by the ISIS trial and think magnesium is not an important option in your care. But cardiologists who are looking for alternatives to drug therapy and to its many side effects, and who read studies thoroughly, are using magnesium successfully. To help you find these doctors, there is a list in the Resources section of complementary medicine associations whose doctors study alternatives to the drug-based medicine they learned in medical school. You can also refer to www.drcarolyndean.com, as I keep abreast of the latest magnesium research.

Because one of the major side effects of heart medications, especially diuretics, is magnesium deficiency, it is vital that magnesium be tested with a Magnesium RBC

test or the EXATest and supplemented in heart patients who are on medication. The dosage ranges from 6 to 10 mg/kg/day (300–1,000 mg per day), but this should be taken only under a doctor's supervision if you are on any other heart medications. See this page for magnesium dosage.

SPASTIC HEART

Between 40 and 60 percent of people who suffer sudden heart attacks may actually have no arterial blockage or history of irregular heartbeats.[34] Two suspected causes are spasms in the coronary arteries and the occurrence of a severe heart rhythm disturbance, such as atrial fibrillation. Both of these conditions can be caused by a deficiency of magnesium. Low magnesium makes the heart muscle hyperirritable, leading to the development of a rhythm disturbance that can't be stopped without emergency medical intervention. An astute physician recognizes the possibility of magnesium deficiency and immediately gives magnesium intravenously, as in the LIMIT trial. Rapid heartbeat or atrial tachycardia, premature beats, and atrial fibrillation have all responded to treatment with IV magnesium.[35], [36], [37]

The most common time for the onset of heart attacks is around 9 A.M. on Mondays as people gird themselves for another long workweek.[38] As mentioned earlier, people who suffer from spasm-induced angina attacks most often experience them at the same time each day, usually in the morning and late afternoon, when magnesium levels are at their lowest. The morning deficiency is likely the result of overnight fasting and the loss of magnesium through the urine. Deficiency in the afternoon may be caused by depletion of magnesium induced by the stress of the day and not yet replenished by the evening meal. In view of this, it seems reasonable that people with angina, heart spasms, hypertension, or heart disease should consult with their doctors and take a Magnesium RBC test; if it is below

optimum (6.0 mg/dL), they could gradually work up to 125–250 mg of magnesium taurate or ½–1 tsp picometer magnesium 3 times per day—before breakfast, at 2 p.m., and before going to bed.

ARRHYTHMIA

Magnesium's ability to neutralize the heart-damaging effects of catecholamines (the products of stress-induced adrenaline and cortisol) is the miracle that can prevent many of the side effects of acute heart attack such as arrhythmia.[39] Magnesium deficiency contributes to abnormal heart rhythms, possibly because magnesium is responsible for maintaining normal potassium and sodium concentrations inside heart muscle cells. A balance of potassium, sodium, calcium, and magnesium allows for normal heart muscle contraction and maintains normal heartbeat. A central pacemaker within the heart muscle creates a normal pumping action that travels across the heart; cardiac arrhythmia occurs when other, less suitable areas of the heart are forced to assume the role of the central pacemaker when it becomes damaged or irritated by lack of oxygen due to blocked blood vessels, caused by drugs (including caffeine), hormonal imbalance, or deficiency of magnesium. These new pacemakers are even more sensitive to magnesium deficiency but are responsive to magnesium therapy, which has been successfully used for over sixty years.[40]

Magnesium is also an accepted treatment for ventricular arrhythmias,[41], [42] congestive heart failure where the heart is weak and unable to empty after each heartbeat,[43], [44] and before and after heart surgery, including coronary bypass grafting.[45], [46], [47] All these studies indicate that the frequency of ventricular arrhythmias is reduced by administration of intravenous magnesium and support an early high-dose administration of intravenous magnesium

in the wake of myocardial infarction.

MITRAL VALVE PROLAPSE

Magnesium deficiency has been implicated in mitral valve prolapse (MVP), a disorder in which the mitral valve fails to completely close off one of the heart chambers during heart contraction. It is also called floppy valve syndrome. Blood rushing through the open valve can be heard as a heart murmur with a stethoscope. When cardiac ultrasound became more commonplace, the diagnosis of MVP escalated, especially in young women. There is no allopathic treatment for the condition, and in mild and even moderate cases it doesn't cause any symptoms. However, patients are usually warned that they should take antibiotics when having dental work done, to prevent the possibility of bacteria from the gums being picked up in the bloodstream and lodging on the prolapsed valve, causing infection. This is a very rare occurrence and some doctors disapprove of this overuse of antibiotics, but it remains a potential liability threat to dentists who don't warn their patients.

Dr. Melvyn Werbach, author of *Nutritional Influences on Disease*, believes that MVP is overdiagnosed and also maintains that it is a magnesium deficiency disease that is well treated by magnesium. The valves of the heart are pulled tight by muscles, which, like any other muscle in the body, depend on magnesium for proper functioning. The mitral valve prolapses because excess calcium relative to magnesium causes it to spasm. Dr. Mildred Seelig reports that low magnesium levels have been found in as many as 85 percent of MVP patients.[48] Sixty percent of 141 individuals with strongly symptomatic MVP had low

magnesium levels, compared to only 5 percent of the control group. Magnesium supplementation given for five weeks reduced the symptoms of chest pain, palpitation, anxiety, low energy, faintness, and difficulty breathing by about 50 percent in this group.[49]

CHELATION THERAPY

Even alternative medicine can make more use of magnesium. Chelation therapy is an intravenous treatment with a chemical called EDTA that pulls out excess calcium from the plaque built up on the arterial walls. It would be much more convenient to use magnesium as part of an oral chelation protocol preventively, to keep calcium from building up in the first place, because balanced amounts of magnesium keep calcium dissolved in the blood and unable to deposit in arterial plaque or kidney stones and gallstones. When intravenous EDTA is used, however, generous amounts of magnesium are usually given as well.

SUPPLEMENTS FOR HEART DISEASE

ReMag: (Picometer-ionic) 150 mg 2–3 times a day and/or

Magnesium taurate: 125 mg four times per day

ReLyte: Mineral-Electrolyte Solution; ½ tsp three times a day

Vitamin E as mixed tocopherols: 400 IU twice a day

Crategus tincture: 20 drops two or three times a day

For cholesterol and atherosclerosis add:

Niacin (vitamin B_3): 250 mg a day, work up to a maximum of 4 grams daily under doctor's supervision. Do not use time-release niacin, which has been associated with liver damage.

Vitamin B complex: 2 per day. Food-based, Grown by Nature

Vitamin C: 1,000 mg three times a day

Vitamin D: 1,000 IU or 20 minutes in the sun daily

Calcium: dietary and/or bone broth, 700mg (see this page for food lists and this page for bone broth recipe)

DIET FOR HEART DISEASE

A good diet is based on free-range chicken, fish (such as wild salmon, which is low in mercury), whole grains, legumes, fruit, and vegetables. Therapeutic foods high in magnesium should be included: garlic, onions, nuts, seeds, wheat germ, and sprouts. Don't fall into the trap of blaming cholesterol above all else. Remember, using margarine is not the answer to heart disease. The proper dietary fats for human consumption are butter, olive oil, flaxseed oil, sesame oil, and coconut oil. The diet for all forms of heart disease should exclude alcohol, coffee, white sugar, white flour, fried foods, and trans fatty acids (found in margarine and in baked, fried, and processed foods). Also read *The Yeast Connection and Women's Health* (Crook and Dean, 2005) and *IBS for Dummies* (Dean and Wheeler, 2005).

CHAPTER EIGHT

OBESITY, SYNDROME X, AND DIABETES

Obesity, syndrome X, and diabetes are part of a continuum of illness that may progress to heart disease if not headed off by good diet, supplements, exercise, and stress reduction. They are not really separate diseases, as we may think, and underlying all this misery we find magnesium deficiency. In fact, there has been a recent addition to our medical vocabulary—it's *diabesity*, a recognition that if someone is about thirty pounds overweight for more than a decade, diabetes will likely occur. People with syndrome X are obese, are on the road to diabetes with insulin resistance, and also have hypertension, elevated cholesterol, and high levels of triglycerides.

THREE THINGS YOU NEED TO KNOW ABOUT MAGNESIUM AND OBESITY

1. Magnesium helps the body digest, absorb, and utilize proteins, fats, and carbohydrates.
2. Magnesium is necessary for insulin to open cell membranes for glucose.

3. Magnesium helps prevent obesity genes from expressing themselves.

THE WEIGHT CONNECTION

Magnesium and the B-complex vitamins are energy nutrients: they activate enzymes that control digestion, absorption, and the utilization of proteins, fats, and carbohydrates. Lack of these necessary energy nutrients causes improper utilization of food, leading to such far-ranging symptoms as hypoglycemia, anxiety, and obesity.

Food craving and overeating can be simply a desire to continue eating past fullness because the body is, in fact, craving nutrients that are missing from processed food. You continue to eat empty calories that pack on the pounds but get you no further ahead in your nutrient requirements.

Magnesium is also necessary in the chemical reaction that allows insulin to usher glucose into cells, where glucose is involved in making energy for the body. If there is not enough magnesium to do this job, both insulin and glucose become elevated. The excess glucose gets stored as fat and contributes to obesity. Having excess insulin puts you on the road toward diabetes.

The connection between stress and obesity cannot be overlooked. The stress chemical cortisol signals a metabolic shutdown that makes losing weight almost impossible. It's as if the body feels it is under an attack such that it must hoard all its resources, including fat stores, and won't let go of them under any inducement. As you read in Chapter 3, magnesium can neutralize the effects of stress.

OBESITY, MORE THAN BAD GENES

The public has been told that obesity is inherited, which makes people think they don't have a hand in creating this problem and can continue their bad habits and blame their genes. Animal experiments show, however, that if a mouse with an obesity gene is deprived of B vitamins, the obesity will be expressed. But if it is fed plenty of B vitamins, it will remain thin. The process of metabolizing B vitamins is called methylation, and magnesium is necessary for one of the most important steps. Every metabolic function in the body requires vitamins and minerals—without them, symptoms develop. Therefore, the first step in treating nonspecific symptoms is diet and dietary supplements, not drugs.

It is also important to note that many of the weight loss diets that people subject themselves to are often deficient in magnesium. The better solution would be to follow the Magnesium Eating Plan outlined in Chapter 17.

ABDOMINAL OBESITY

Gaining weight around your middle is related to magnesium deficiency and an inability to properly utilize insulin. It also sets the stage for syndrome X. You only need a tape measure to diagnose a predisposition to syndrome X —a waist size above 40 inches in men and above 35 in women puts you at risk.

In their book *The Magnesium Factor*, authors Mildred Seelig, M.D., and Andrea Rosanoff, Ph.D., take note of research showing that over half the insulin in the bloodstream is directed at abdominal tissue. They theorize that as more and more insulin is produced to deal with a high-sugar diet, abdominal girth increases to process the extra insulin.

SYNDROME X

The term "syndrome X" describes a set of conditions that many believe is just another fancy name for the consequences of long-standing nutritional deficiency, especially magnesium deficiency. The long list includes high cholesterol and hypertension, detailed in Chapter 6, and obesity. It also encompasses elevated triglycerides and elevated uric acid. High triglycerides are usually found when cholesterol is elevated but most often when someone has a high-sugar diet, such as from drinking sodas daily and eating cakes and pastries. High uric acid is due to incomplete breakdown of protein from lack of B vitamins and digestive enzymes. This complex collectively appears to be caused by disturbed insulin metabolism (initiated by magnesium deficiency), called insulin resistance, and eventually can lead to diabetes, angina, and heart attack.

As previously noted, magnesium is required in the metabolic pathways that allow insulin to usher glucose into cells, where glucose participates in making energy for the body. If magnesium is deficient, the doorway into the cells does not open to glucose, resulting in the following cascade of events:

1. Glucose levels become elevated.
2. Glucose is stored as fat and leads to obesity.
3. Elevated glucose leads to diabetes.
4. Obesity puts a strain on the heart.
5. Excess glucose becomes attached to certain proteins (glycated), leading to kidney damage,

neuropathy, blindness, and other diabetic complications.

6. Insulin-resistant cells don't allow magnesium into the cells.

7. Further magnesium deficiency leads to hypertension.

8. Magnesium deficiency leads to cholesterol buildup, and both these conditions are implicated in heart disease.

Syndrome X, according to Dr. Gerald Reaven, who coined the term, may be responsible for a large percentage of the heart and artery disease that occurs today. Unquestionably, magnesium deficiency is a major factor in the origins of each of its signs and symptoms, from elevated triglycerides and obesity to disturbed insulin metabolism.[1], [2]

INSULIN RESISTANCE

Insulin's job is to open up sites on cell membranes to allow the influx of glucose, a cell's source of fuel. Cells that no longer respond to the advances of insulin and refuse the entry of glucose are called insulin-resistant. As a result, blood glucose levels rise and the body produces more and more insulin, to no avail. Glucose and insulin rampage throughout the body, causing tissue damage that results in overuse and wasting of magnesium, an increased risk of heart disease, and adult-onset diabetes. One of the major reasons the cells don't respond to insulin is lack of magnesium.[3] Some studies show that chronic insulin resistance in patients with type II diabetes is associated with a reduction of magnesium; magnesium is necessary to allow glucose to enter cells.[4] Additional studies confirm that when insulin is released from the pancreas, magnesium in the cell normally responds and opens the cell to allow entry of glucose, but in the case of magnesium deficiency combined with insulin resistance the normal mechanisms just don't work.[5] However, the higher the levels of magnesium in the body, the greater the sensitivity of the cells to insulin and the possibility of reversing the problem.[6]

CARDIOVASCULAR METABOLIC SYNDROME (CVMS)

Dr. Larry Resnick of Cornell University, involved in heart and magnesium research for over twenty years, has another name for syndrome X. He calls it cardiovascular metabolic syndrome (CVMS), and Dr. Resnick is closer to the truth about this condition when he says it is characterized by a high calcium-to-magnesium ratio. (Remember, too much calcium automatically creates a magnesium deficiency.)[7] Americans in general have a high calcium-to-magnesium ratio in their diet and consequently in their bodies. Finland, which has the highest incidence of heart attack in middle-aged men in the world, also has a high calcium-to-magnesium ratio in the diet. The U.S. ratio in this study is said to be 3.5:1, Finland's 4:1.[8] (With our dietary emphasis on a high calcium intake without sufficient magnesium, according to magnesium expert Dr. Mildred Seelig, we will soon be faced with a 6:1 ratio in our population.) The conventional recommended dietary ratio of calcium to magnesium, 2:1, has been debunked. To reverse syndrome X, it may be necessary to only use 600 mg per day of dietary calcium and 600 mg of magnesium in supplement form and not use any supplemental calcium.